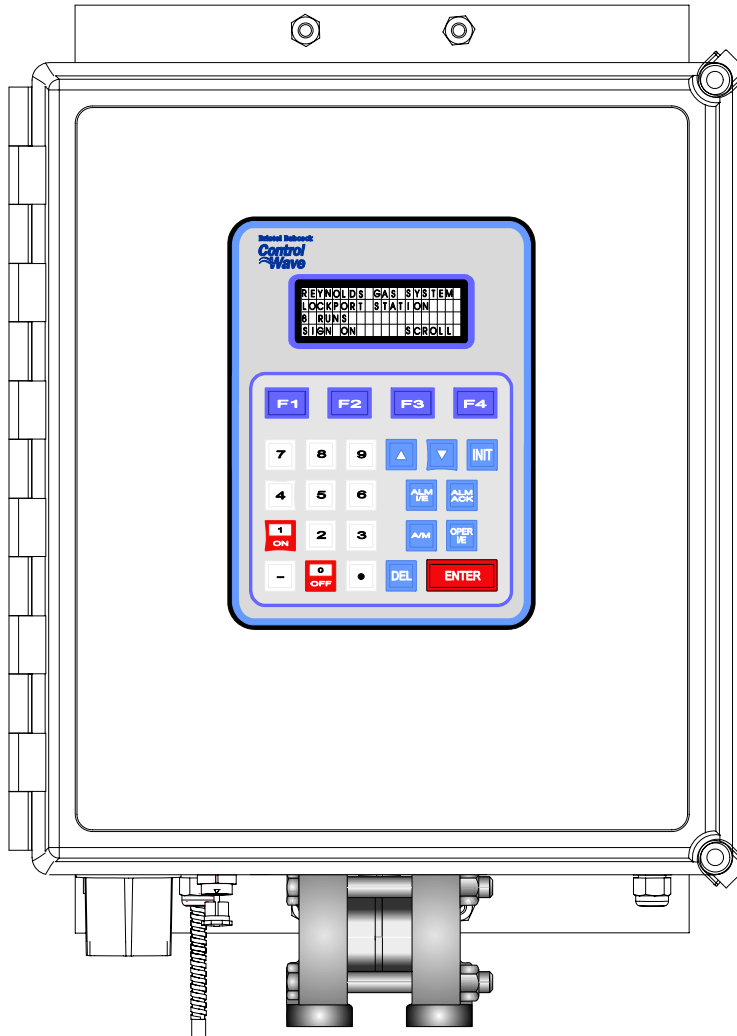# ControlWave EFM
(Electronic Flow Meter)

Bristol

EMERSON
Process Management

IMPORTANT! READ INSTRUCTIONS BEFORE STARTING!

Be sure that these instructions are carefully read and understood before any operation is attempted. Improper use of this device in some applications may result in damage or injury. The user is urged to keep this book filed in a convenient location for future reference.

These instructions may not cover all details or variations in equipment or cover every possible situation to be met in connection with installation, operation or maintenance. Should problems arise that are not covered sufficiently in the text, the purchaser is advised to contact Bristol for further information.

EQUIPMENT APPLICATION WARNING

The customer should note that a failure of this instrument or system, for whatever reason, may leave an operating process without protection. Depending upon the application, this could result in possible damage to property or injury to persons. It is suggested that the purchaser review the need for additional backup equipment or provide alternate means of protection such as alarm devices, output limiting, fail-safe valves, relief valves, emergency shutoffs, emergency switches, etc. If additional in-formation is required, the purchaser is advised to contact Bristol .

RETURNED EQUIPMENT WARNING

When returning any equipment to Bristol for repairs or evaluation, please note the following: The party sending such materials is responsible to ensure that the materials returned to Bristol are clean to safe levels, as such levels are defined and/or determined by applicable federal, state and/or local law regulations or codes. Such party agrees to indemnify Bristol and save Bristol harmless from any liability or damage which Bristol may incur or suffer due to such party's failure to so act.

ELECTRICAL GROUNDING

Metal enclosures and exposed metal parts of electrical instruments must be grounded in accordance with OSHA rules and regulations pertaining to "Design Safety Standards for Electrical Systems," 29 CFR, Part 1910, Subpart S, dated: April 16, 1981 (OSHA rulings are in agreement with the National Electrical Code).

The grounding requirement is also applicable to mechanical or pneumatic instruments that include electrically-operated devices such as lights, switches, relays, alarms, or chart drives.

EQUIPMENT DAMAGE FROM ELECTROSTATIC DISCHARGE VOLTAGE

This product contains sensitive electronic components that can be damaged by exposure to an electrostatic discharge (ESD) voltage. Depending on the magnitude and duration of the ESD, this can result in erratic operation or complete failure of the equipment. Read supplemental document S14006 at the back of this manual for proper care and handling of ESD-sensitive components.

WARRANTY

A.   Bristol warrants that goods described herein and manufactured by Bristol are free from defects in material and workmanship for one year from the date of shipment unless otherwise agreed to by Bristol in writing.

B.   Bristol warrants that goods repaired by it pursuant to the warranty are free from defects in material and workmanship for a period to the end of the original warranty or ninety (90) days from the date of delivery of repaired goods, whichever is longer.

C.   Warranties on goods sold by, but not manufactured by Bristol, are expressly limited to the terms of the warranties given by the manufacturer of such goods.

D.   All warranties are terminated in the event that the goods or systems or any part thereof are (i) misused, abused or otherwise damaged, (ii) repaired, altered or modified without Bristol's consent, (iii) not installed, maintained and operated in strict compliance with instructions furnished by Bristol, or (iv) worn, injured or damaged from abnormal or abusive use in service time.

E.   THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION WARRANTIES AS TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), AND NO WARRANTIES, EXPRESS OR IMPLIED, NOR ANY REPRESENTATIONS, PROMISES, OR STATEMENTS HAVE BEEN MADE BY BRISTOL UNLESS ENDORSED HEREIN IN WRITING. FURTHER, THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION OF THE FACE HEREOF.

F.   No agent of Bristol is authorized to assume any liability for it or to make any written or oral warranties beyond those set forth herein.

REMEDIES

A.   Buyer's sole remedy for breach of any warranty is limited exclusively to repair or replacement without cost to Buyer of any goods or parts found by Seller to be defective if Buyer notifies Bristol in writing of the alleged defect within ten (10) days of discovery of the alleged defect and within the warranty period stated above, and if the Buyer returns such goods to Bristol's Watertown office, unless Bristol's Watertown office designates a different location, transportation prepaid, within thirty (30) days of the sending of such notification and which upon examination by Bristol proves to be defective in material and workmanship. Bristol is not responsible for any costs of removal, dismantling or reinstallation of allegedly defective or defective goods. If a Buyer does not wish to ship the product back to Bristol, the Buyer can arrange to have a Bristol service person come to the site. The Service person's transportation time and expenses will be for the account of the Buyer. However, labor for warranty work during normal working hours is not chargeable.

B.   Under no circumstances will Bristol be liable for incidental or consequential damages resulting from breach of any agreement relating to items included in this quotation, from use of the information herein or from the purchase or use by Buyer, its em-ployees or other parties of goods sold under said agreement.

How to return material for Repair or Exchange

Before a product can be returned to Bristol for repair, upgrade, exchange, or to verify proper operation, form (GBU 13.01) must be completed in order to obtain a RA (Return Authorization) number and thus ensure an optimal lead time. Completing the form is very important since the information permits the Bristol Repair Dept. to effectively and efficiently process the repair order.

You can easily obtain a RA number by:

A. FAX
Completing the form (GBU 13.01) and faxing it to (860) 945-3875. A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

B. E-MAIL
Accessing the form (GBU 13.01) via the Bristol Web site (www.bristolbabcock.com) and sending it via E-Mail to brepair@bristolbabcock.com. A Bristol Repair Dept. representative will return E-Mail (or other requested method) with a RA number.

C. Mail
Mail the form (GBU 13.01) to

> **Bristol Inc.**
> Repair Dept.
> 1100 Buckingham Street
> Watertown, CT 06795

A Bristol Repair Dept. representative will return call (or other requested method) with a RA number.

D. Phone
Calling the Bristol Repair Department at (860) 945-2442. A Bristol Repair Department representative will record a RA number on the form and complete Part I, then send the form to the Customer via fax (or other requested method) for Customer completion of Parts II & III.

A copy of the completed Repair Authorization Form with issued RA number should be included with the product being returned. This will allow us to quickly track, repair, and return your product to you.

Bristol Inc. Repair Authorization Form (off-line completion)

(Providing this information will permit Bristol Inc. to effectively and efficiently process your return. Completion is required to receive optimal lead time. Lack of information may result in increased lead times.)

Date_____   RA #_____SH_   Line No._____

Standard Repair Practice is as follows: Variations to this is practice may be requested in the "Special Requests" section.
- Evaluate / Test / Verify Discrepancy
- Repair / Replace / etc. in accordance with this form
- Return to Customer

Please be aware of the Non warranty standard charge:
- There is a $100 minimum evaluation charge, which is applied to the repair if applicable (√ in "returned" B,C, or D of part III below)

Part I   Please complete the following information for single unit or multiple unit returns

Address No. _____ (office use only)   **Address No.** _____(office use only)

Bill to :_____   **Ship to:**_____

_____   _____

_____   _____

Purchase Order:_____   **Contact Name:**_____

Phone:_____ **Fax:**_____ **E-Mail:** _____

Part II   Please complete Parts II & III   for each unit returned

Model No./Part No._____   **Description** _____

Range/Calibration _____   **S/N** _____

Reason for return : ☐ Failure   ☐ Upgrade   ☐ Verify Operation   ☐ Other _____

1. Describe the conditions of the failure (Frequency/Intermittent, Physical Damage, Environmental Conditions, Communication, CPU watchdog, etc.)

_____

_____

_____

_____(Attach a separate sheet if necessary)

2. Comm. interface used: ☐ Standalone ☐ RS-485 ☐ Ethernet ☐ Modem (PLM (2W or 4W) or SNW) ☐Other:_____

3. What is the **Firmware** revision? _____   What is the **Software** &version? _____

Part III If checking "replaced" for any question below, check an alternate option if replacement is not available

A. If product is within the warranty time period but is excluded due to Bristol's warranty clause, would you like the product: ☐ repaired ☐ returned ☐ replaced ☐ scrapped?

B. If product were found to exceed the warranty period, would you like the product: ☐repaired ☐ returned ☐ replaced ☐ scrapped?

C. If product is deemed not repairable would you like your product: ☐ returned ☐ replaced ☐ scrapped?

D. If Bristol is unable to verify the discrepancy, would you like the product: ☐ returned ☐ replaced ☐ *see below?

* Continue investigating by contacting the customer to learn more about the problem experienced? The person to contact that has the most knowledge of the problem is: _____ phone_____
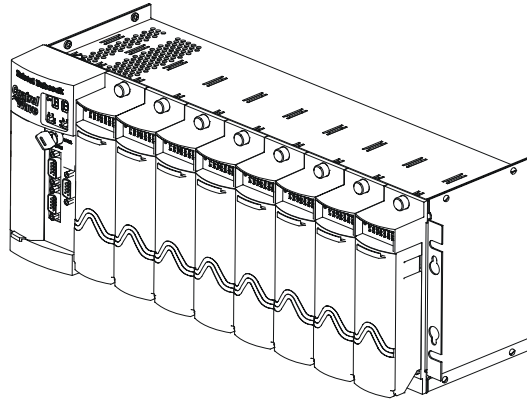
If we are unable to contact this person the backup person is: _____ phone_____

Special Requests: _____

_____

Ship prepaid to: **Bristol Inc., Repair Dept., 1100 Buckingham Street, Watertown, CT 06795**
                   Phone: 860-945-2442   Fax: 860-945-3875   Form GBU 13.01 Rev. B 04/11/06

Bristol
Training

GET THE MOST FROM YOUR BRISTOL BABCOCK INSTRUMENT OR SYSTEM

- Avoid Delays and problems in getting your system on-line

- Minimize installation, start-up and maintenance costs.

- Make the most effective use of our hardware and software.

- Know your system.
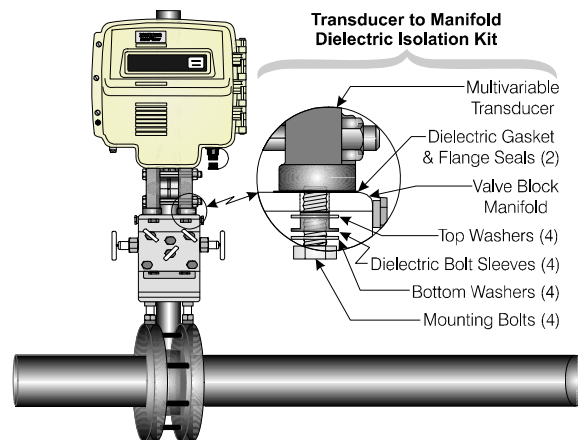
As you know, a well-trained staff is essential to your operation. Bristol Inc. offers a full schedule of classes conducted by full-time, professional instructors. Classes are offered throughout the year at three locations: Houston, Orlando and our Watertown, CT headquarters. By participating in our training, your personnel can learn how to install, calibrate, configure, program and maintain any and all Bristol products and realize the full potential of your system.

For information or to enroll in any class, contact our training department in Watertown at (860) 945-2343. For Houston classes, you can also contact our Houston office, at (713) 685-6200.

A Few Words About Bristol Inc.

For over 100 years, Bristol® has been providing innovative solutions for the measurement and control industry. Our product lines range from simple analog chart recorders, to sophisticated digital remote process controllers and flow computers, all the way to turnkey SCADA systems. Over the years, we have become a leading supplier to the electronic gas measurement, water purification, and wastewater treatment industries.

On off-shore oil platforms, on natural gas pipelines, and maybe even at your local water company, there are Bristol Inc. instruments, controllers, and systems running year-in and year-out to provide accurate and timely data to our customers.

Getting Additional Information

In addition to the information contained in this manual, you may receive additional assistance in using this product from the following sources:

Help Files / Release Notes

Many Bristol software products incorporate help screens. In addition, the software typically includes a 'read me' release notes file detailing new features in the product, as well as other information which was available too late for inclusion in the manual.

Contacting Bristol Inc. Directly

Bristol's world headquarters is located at 1100 Buckingham Street, Watertown, Connecticut 06795, U.S.A.

Our main phone numbers are:

(860) 945-2200
(860) 945-2213 (FAX)

Regular office hours are Monday through Friday, 8:00AM to 4:30PM Eastern Time, excluding holidays and scheduled factory shutdowns. During other hours, callers may leave messages using Bristol's voice mail system.

Telephone Support - Technical Questions

During regular business hours, Bristol's Application Support Group can provide telephone support for your technical questions.

For technical questions about TeleFlow products call (860) 945-8604.

For technical questions about **Control**Wave call (860) 945-2394 or (860) 945-2286.

For technical questions regarding Bristol's **OpenEnterprise** product, call (860) 945-3865 or e-mail: **scada@bristolbabcock.com**

For technical questions regarding **ACCOL** products, **OpenBSI Utilities**, **UOI** and all other software except for **Control**Wave and **OpenEnterprise** products, call (860) 945-2286.

For technical questions about **Network 3000** hardware, call (860) 945-2502.

You can e-mail the Application Support Group at: **bsupport@bristolbabcock.com**

The Application Support Group maintains an area on our web site for software updates and technical information. Go to: **www.bristolbabcock.com/services/techsupport/**

For assistance in interfacing Bristol hardware to radios, contact Bristol's **Communication Technology Group** in Orlando, FL at **(407) 629-9463 or (407) 629-9464**.

You can e-mail the Communication Technology Group at:
orlandoRFgroup@bristolbabcock.com

Telephone Support - Non-Technical Questions, Product Orders, etc.

Questions of a non-technical nature (product orders, literature requests, price and delivery information, etc.) should be directed to the nearest sales office (listed on the rear cover of this manual) or to your Bristol-authorized sales representative.

Please call the main Bristol Inc. number (860-945-2200) if you are unsure which office covers your particular area.

Visit our Site on the World Wide Web

For general information about Bristol Inc. and its products, please visit our site on the World Wide Web at: **www.bristolbabcock.com**

Training Courses

Bristol's Training Department offers a wide variety of courses in Bristol hardware and software at our Watertown, Connecticut headquarters, and at selected Bristol regional offices, throughout the year. Contact our Training Department at **(860) 945-2343** for course information, enrollment, pricing, and scheduling.

CI-ControlWave EFM

ControlWave EFM
Electronic Flow Meter

INSTALLATION FORWARD

NOTE for all ControlWave EFM Installers:

READ THIS SECTION FIRST!

This manual has been designed for the following audience:

- Customer Site Engineers, who must plan for the installation and implementation of the ControlWave **EFM**.

- Instructors who must become familiar with and teach Field Engineers/Technicians on the installation, operation and repair of **Control**Wave **EFM**.

- Field Engineers/Technicians who must install and service the **Control**Wave **EFM**.

Installation of the ControlWave **EFM** electronic flow meter is provided in two formats as follows:

Section 2 - <u>Installation & Operation</u> provides a detailed overview of the installation and operation of the ControlWave **EFM**. Section 2 provides all the information required for instructors who are training individuals unfamiliar with the **Control**Wave **EFM**. It is also intended to support anyone who needs to learn how to install and operate the **Control**Wave **EFM** for the first time.

Appendix C - <u>Hardware Installation Guide</u> is intended for individuals who are already familiar with the **Control**Wave **EFM** but need the configuration information in a concise format. Field Engineers/Technicians who have previously installed one or more **Control**Wave **EFM** electronic flow meters will find the necessary installation information logically sequenced for their convenience.

NOTE:

A Windows driven diagnostic tool referred to as WINDIAG is provided on the OpenBSI Software CDROM. WINDIAG is documented in instruction manual D4041A – <u>Window Diagnostics for Bristol Controllers</u>. Bristol's WINDIAG program provides menu driven diagnostics that have been designed to assist a technician or Process Engineer in troubleshooting the various ControlWave EFM circuits. A brief overview is provided in Section 3.5 of this manual. For more detailed descriptions of ControlWave EFM Windows Diagnostics than those provided herein, see Document D4041A – Chapters 1 and 7B.

CI-ControlWave EFM

ControlWave EFM
Electronic Flow Meter

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Section 1
ControlWave EFM INTRODUCTION

1.1 GENERAL DESCRIPTION

ControlWave **EFM** electronic flow meters measure differential pressure, static pressure and temperature for a single run and compute flow for both volume and energy. In addition to operation in an unprotected outdoor environment, the **Control**Wave **EFC** electronic flow meter provides the following key features.

- ARM processor provides exceptional performance and low power consumption
- Wide operating temperature range: (-40 to +70°C) (-40 to 158°F)
- CPU, SCM & I/O Modules provide LED status Indicators
- Battery backup for the real-time clock and the system's SRAM is provided by a 3.0V, 300mA-hr lithium coin cell battery located on the CPU Module.
- Very low power consumption
- Integral Multivariable Transducer (MVT) with "smart" performance
- Standard Application Program supports the following Flow calculations:
  - Calculates AGA3-1995/NX-19
  - AGA3-1992 with selectable AGA8 Gross or AGA8 Detail
  - AGA7/NX-19
  - AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Auto Adjust AGA7/NX-19
  - Auto Adjust AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Instromet Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Daniel Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
- Three serial communications ports (Two RS-232 & One RS-485)
- Four line alphanumeric display (with dual-button Keypad or 25-button Keypad)
- User choice of I/O Modules (AI/AO, AI, DI/DO, HSC and Mixed I/O)
- RTD input
- Nonincendive Class I, Div. 2, Groups C & D Hazardous Locations (see Appendix A)
- RTD input
- Optional Expansion Comm. Modules with/without built-in modem and/or radio
- Chassis Slots 3 and 4 support Expansion Comm. Modules or I/O Modules or one of each
- Optional Display/Keypad System
- Mixed I/O Modules provide cost effective I/O for small RTU applications

ControlWave **EFC** electronic flow meters are furnished in a NEMA 3X rated Hoffman® Enclosure. The flow computer hardware is comprised of a Backplane Board (mounted in a Housing), a System Controller Module and a CPU Module. Optional Expansion Communication Modules may reside in Slots 3 and 4 of the Housing in lieu of I/O Modules. The CPU Module utilizes Sharp's LH7A400 System-on-Chip Advanced RISC Machine (ARM) microprocessor with 32-bit ARM9TDMI Reduced Instruction Set Computer (RISC) Core. In addition to the microprocessor and control logic, the CPU Board includes two RS-232 communication ports, one RS-485 Communication port, 2MB of battery backed Static RAM (SRAM), 512kB Boot/Downloader FLASH, 8MB simultaneous read/write FLASH, and an I/O Bus Connector.

All system modules plug into the Backplane Board (4-Slot or 8-Slot). Each I/O Module provides the circuitry and field interface hardware necessary to interconnect the assigned field I/O circuits. Non-isolated power is generated and regulated by the System Controller Module (SCM) that provides +3.3Vdc for all logic and bulk power for I/O field circuits from either a bulk 6Vdc or bulk 12Vdc source. +1.8Vdc, used by the ARM microprocessor, is

generated on the CPU Module (derived from the regulated 3.3Vdc logic power). In addition to Idle and Watchdog LEDs, there are six status LEDs located on the SCM that will display run time status information.
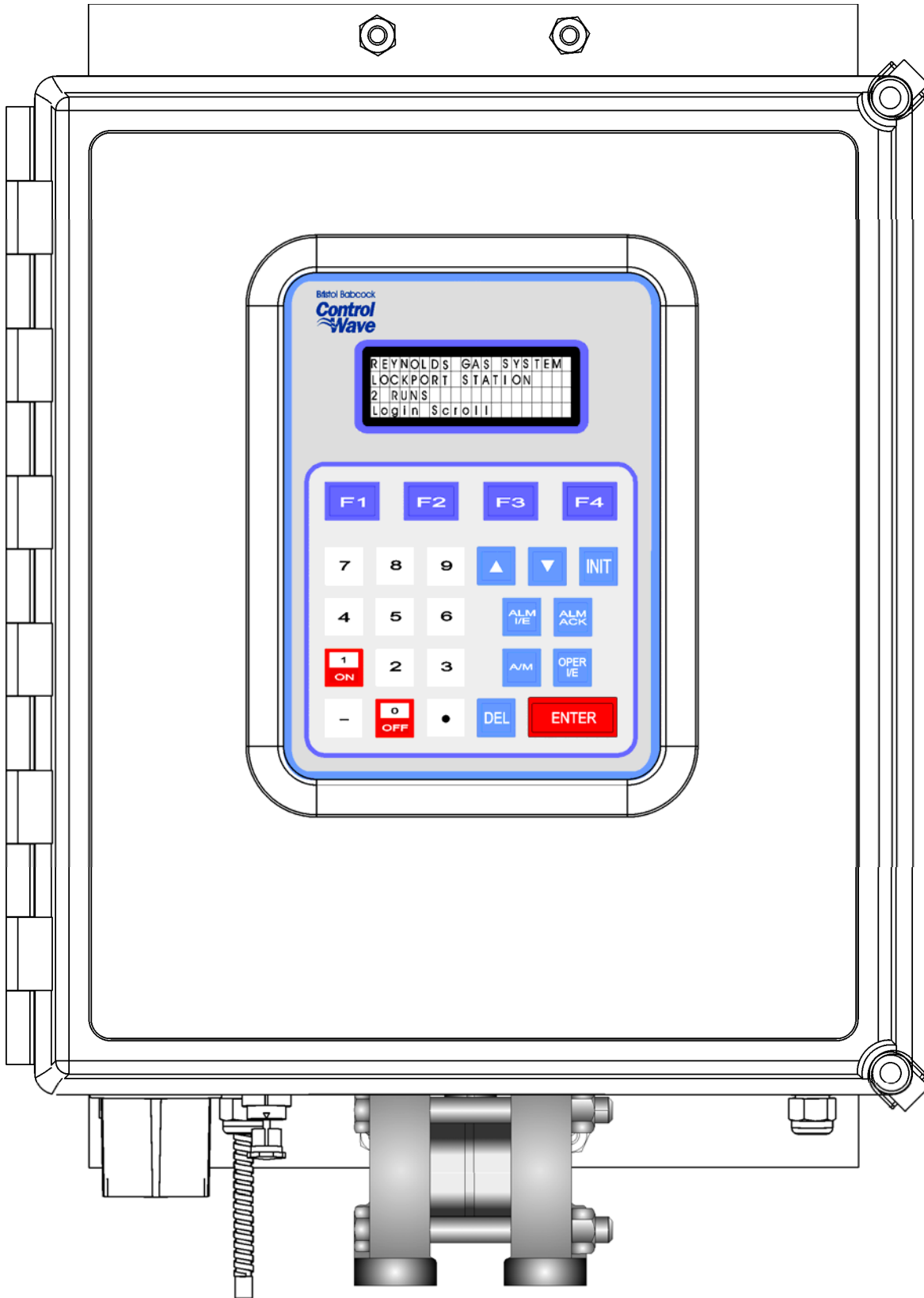
Figure 1-1 - Control Wave **EFM Enclosure**
(with 25-Button Display/Keypad Assembly)(Shown with Circular Local Port)

1. Fabrication Panel
2. ControlWave MICRO EFM 4-Slot Base Assembly (from Left to Right - SCM, CPU & 2 I/O Modules)
3. .5" Liquit Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug
8. 1" NPT Conduit Hub
9. Local Comm. Port Connector

10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board
16. Rechargeable, Sealed Lead-Acid Battery (Secured by Battery Mounting Bracket)

Figure 1-2A - 4-Slot ControlWave EFM (Internal View)
Component Identification Diagram (Shown with D-Type Local Port)

Figure 1-2B - 8-Slot ControlWave EFM (Internal View)
Component Identification Diagram (Shown with Circular Local Port)

1. Fabrication Panel
2. ControlWave MICRO EFM 8-Slot Base Assembly (from Left to Right - SCM, CPU & 6 I/O Modules)
3. .5" Liquid Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug (Behind Item #8)
8. 1" NPT Conduit Hub
9. Local Comm. Port Connector
10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board

Figure 1-3 - 8/4-Slot ControlWave EFM (Electronic Flow Meter) Base Assemblies
(The 4-Slot Chassis is shown with ECM Modules in Slots 3 & 4)

1.2 ControlWave PROGRAMMING ENVIRONMENT

The **Control**Wave programming environment uses industry-standard tools and protocols to provide a flexible, adaptable approach for various process control applications in the water treatment, wastewater treatment, and industrial automation business.

ControlWave **EFM** units provide an ideal platform for remote site automation, measurement, and data management in the oil and gas industry.

The control strategy file created and downloaded into the controller is referred to as a **Control**Wave **project**. The **Control**Wave **EFM** ships from Bristol Babcock with a standard **Control**Wave project, pre-configured for gas flow measurement, already loaded and ready to run.

The **Control**Wave programming environment consists of a set of integrated software tools which allow a user to modify the standard gas flow measurement project to fit the needs of their own particular application, as well as to create, test, implement, and download a different **Control**Wave project, if desired.

The tools that make up the programming environment are:

- **Control**Wave **Designer** load building package offers several different methods for generating and debugging control strategy programs including function blocks, ladder logic, structured languages, etc. The resulting process control load programs are fully compatible with **IEC 61131-3** standards. Various communication methods as offered, including TCP/IP, serial links, as well as communication to Bristol Babcock's **Open BSI** software and networks.
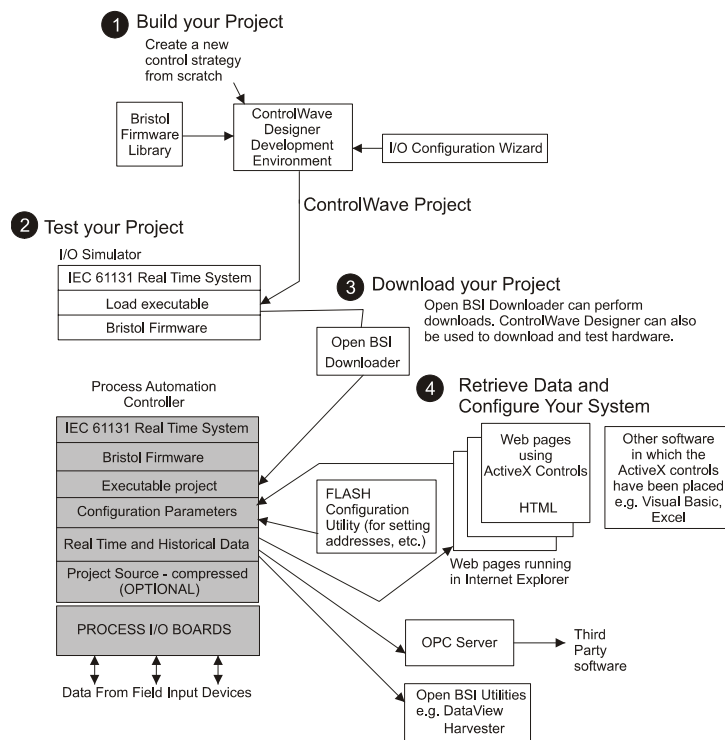
Figure 1-4 - Control Wave **- Control Strategy Software Diagram**

- The **I/O Configuration Wizard**, accessible via a menu item in **Control**Wave Designer, allows you to define **process I/O modules** in the **Control**Wave and con-figure the individual mapping of I/O points for digital and analog inputs and outputs.

- The **ACCOL3 Firmware Library** which is imported into **Control**Wave Designer, includes a series of Bristol Babcock specific function blocks. These pre-programmed

function blocks accomplish various tasks common to most user applications including alarming, historical data storage, as well as process control algorithms such as PID control.

- The **OPC Server** (**O**bject Linking and Embedding (OLE) for **P**rocess **C**ontrol) allows real-time data access to any OPC [Object Linking and Embedding (OLE) for Process Control] compliant third-party software packages.

- A set of **Control**Wave **EFM** web pages is provided to set configuration parameters for the standard gas flow measurement project, running in the unit. These web pages use Bristol Babcock-specific **ActiveX controls** for retrieval of real-time data values and communication statistics from the unit. The ActiveX controls are compatible with Microsoft® Internet Explorer. Alternatively, developers can place the ActiveX controls in third-party ActiveX compatible containers such as Visual BASIC or Microsoft® Excel.

- **User-defined Web Pages** – Users can place the *same* ActiveX controls into their own web pages to provide a customized human-machine interface (HMI) to the **Control**Wave **EFM**.

- **Flash Configuration Utility** – Parameters such as the BSAP local address, IP address, etc. are set using the Flash Configuration Utility, accessible via Open BSI LocalView or NetView. The **Control**Wave **EFM** ships with a standard Flash Configuration Profile (FCP) file, with default configuration parameters already set.

1.3 PHYSICAL DESCRIPTION

ControlWave **EFM** electronic flow meters are comprised of the following major components:

- Enclosure with Local Communications Port (RS-232) and LCD Display (Section 1.3.1)
- CPU Module (Section 1.3.2)
- System Controller Module (Section 1.3.3)
- Backplane (Section 1.3.4)
- Base Assembly (Chassis) (Section 1.3.5)
- Up to two I/O Modules (Section 1.3.6) or two Expansion Communication Modules (see Section 1.3.7) - (or one of either, one of each, or none)
- Internal Mounting Brackets (Section 1.3.8)

ControlWave **EFMs** can be factory configured with the following options:

- Multivariable Transducer (Section 1.3.9)
- Power Distribution Board (Section 1.3.10)
- Digital to Relay I/O Board (Section 1.3.11)
- 21V Power Supply Board (Section 1.3.12)
- Power System - Solar Panel (30W) & 33AH Lead-acid Battery (with Battery Charger/-Power Manager Board (Section 1.3.13)
- RTD Probe (Section 1.3.14)
- External Radio/Modem (Section 1.3.15)

1.3.1 Enclosure

ControlWave **EFMs** are housed in a standard Hoffman® Enclosure. External dimensions (excluding added hardware and Cover Latches) are approximately 14.56" high, by 12.97" wide, by 8.31" deep. When present, the Multivariable Transducer adds 2.89" to the height of the unit. The enclosure consists of two pieces, the body and the Instrument Front Cover. A continuous gasket seals the unit when the Instrument Front Cover is closed. A hinge on the left side (facing the front of the unit) is formed by molded channels on the Instrument Front Cover and the body that capture a stainless steel pin. Two latches on the enclosure's right side secure the Instrument Front Cover when it is closed.

A weatherproof communication connector, either a 9-Pin male D-Type connector or a a circular 3-pin connector, (the Local Port) is mounted to the bottom of the enclosure and connected internally to RS-232 Comm. Port 1 provides connection for a local communications device, typically a PC. Communications rate is configurable 300 to 115.2 KB (115.2 KB - default).

Enclosures are provided with either a 2-button 4 X 20 LCD display or a 4 X 20 LCD display supported by a 25-button keypad. In normal operation, the display stays off after the unit has been configured and placed into service. The operator may activate the display at any time by pressing the appropriate front panel button.

1.3.2 CPU Module

The CPU Module houses the CPU Board. This multilayer board provides **Control**Wave **MICRO EFM** CPU, I/O monitor/control, memory and communication functions. **Control**Wave **MICRO EFM** CPU Modules operate over an extended temperature range with long-term product reliability.

ControlWave **EFM** CPU Boards are based on Sharp's LH7A400 System-on-Chip ARM microprocessor with 32-bit ARM9TDMI RISC Core. The CPU operates at 1.8V with a system clock speed of 33 MHz. The Microcontroller is packaged in a 256-pin Plastic Ball Grid Array. In addition to the microprocessor and control logic, the CPU Board includes two RS-232 and one RS-485 communication ports, 2MB of battery backed Static RAM (SRAM), 512kB Boot/Downloader FLASH, 8MB simultaneous read/write FLASH and an I/O Bus Connector.

CPU Modules are provided backup power via a piggyback mounted Battery Backup board equipped with a coin cell socket that accepts a 3.0V, 300mA-hr lithium battery. This 3.0V battery provides backup power for the real-time clock and the system's Static RAM (SRAM). Backup power is enabled when JP1 on the Battery Backup Bd. is installed.

If the 3.3Vdc that powers the unit goes out of specification, a supervisory circuit on the Battery Backup Board switches the battery voltage to the VBAT3.3 hardware signal (used by the CPU's SRAM and RTC). This supervisory circuit also generates a BATTERYGOOD signal when the battery voltage is above 2.2V.

The system SRAM is specified to have a standby current of 20µA maximum for each part (plus 2uA for the RTC). For a system containing 2MB of System SRAM, a worst-case current draw of 42µA allows a battery life of approximately 7142 hours.

A supervisory circuit is used to switch to battery power when VCC falls out of specification. For maximum shelf life, the battery may be isolated from the circuit by removing the

Backup Battery Jumper JP1 (on the Battery Backup Board) from position 1 to 2 and then storing it on either pin. If the Real-time clock looses its battery backup a ControlWave Designer system variable bit (_QUEST_DATE) is set. This bit can be used to post a message or alarm to the PC (see the 'Systems Variables' section of the ControlWave Designer Programmer's Handbook D5125).
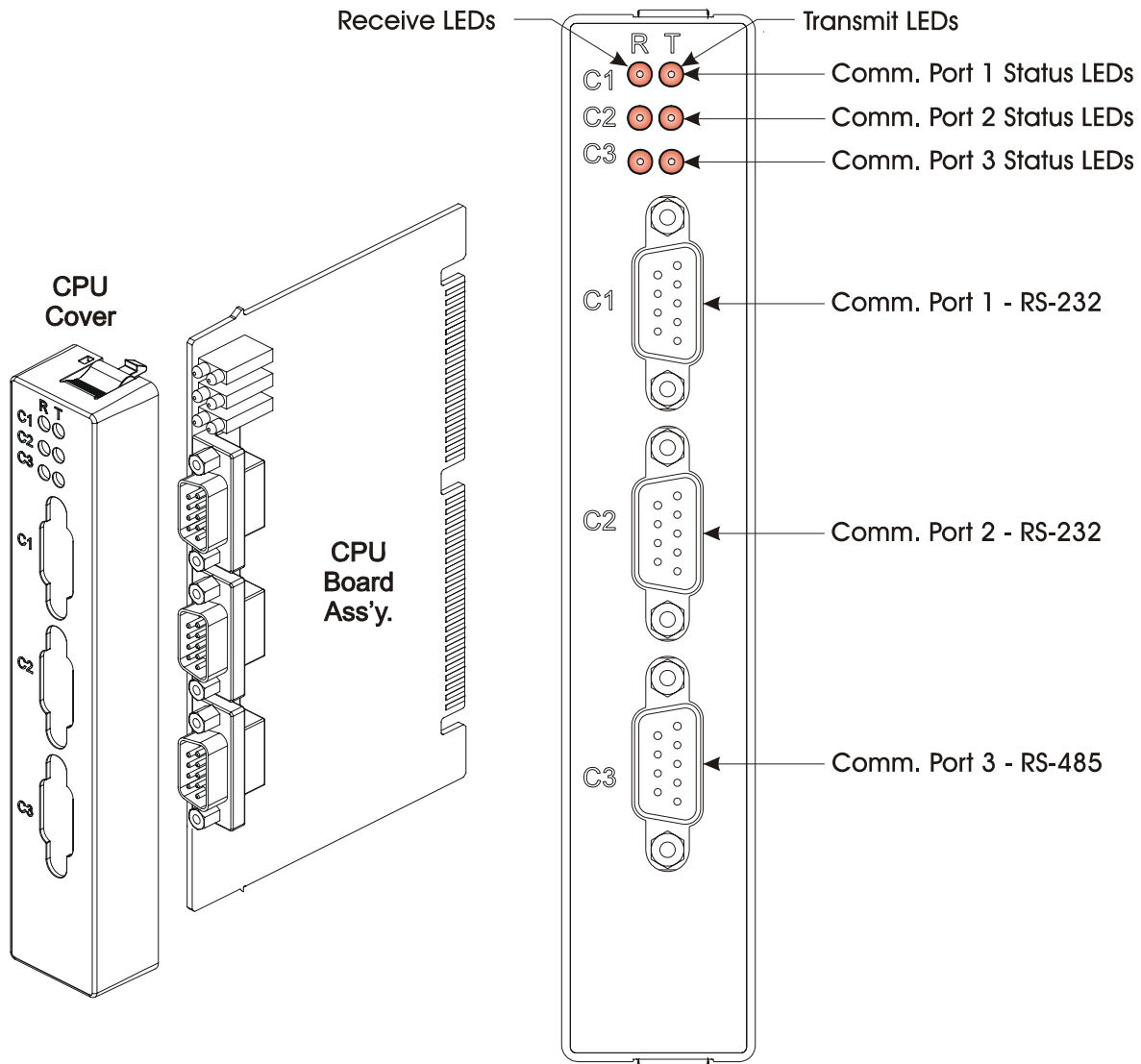
Figure 1-5 – Control Wave **EFM CPU Module**

Basic CPU components and features are summarized as follows:

- LH7A400 System-on-Chip 32-bit ARM9TDMI RISC Core microprocessor
- 512KB FLASH Boot/Downloader, 29LV040B, 90 nS, 8-bit access
- 2MB SRAM, 3.3V, 512K x 32, with Battery Back-up
- 8MB simultaneous read/write FLASH, TSOP sites
- Two 9 wire PC2 compatible (RS-232) serial communications ports with modem control pins and one 5 wire RS-485 Comm. port
- I/O Bus Interface capable of driving up to 14 I/O Modules
- Spread Spectrum clock for lower EMI
- Two Status LEDs per Comm. Port
- 8-Position general-purpose switch bank plus a 4-Position recovery switch bank
- Coin cell socket accepts a 3.0V, 300mA-hr lithium battery

1.3.2.1 CPU Module Connectors

The CPU Modules contain up to seven connectors that function as follows (see Table 1-1):

Table 1-1 - CPU Board Connector Summary

Ref.	# Pins	Function	Notes
P1	76-Pin	Factory Debug	Not user accessible
P2	36-pin	Card Edge Backplane I/O Bus Intf.	see Figure 2-9
P3	44-pin	Card Edge Backplane SCM Intf.	see Figure 2-8
J2	10-Pin	PLD JTAG Header	Not user accessible
J3	9-pin	COM1 9-pin male D-sub (RS-232)	see Figure 2-11 & Table 2-3 or 4-2
J4	9-pin	COM2 9-pin male D-sub (RS-232)	see Figure 2-11 & Table 2-3 or 4-2
J5	9-pin	COM3 9-pin male D-sub (RS-485)	see Figure 2-11 & Table 2-3 or 4-2

CPU Module Comm. Port Connectors J3, J4 and J5
The CPU Module supports up to two external 9-pin RS-232 serial communication ports
(COM1 and COM2) and an external 9-pin RS-485 serial communication port (COM3).
COM1 and COM2 and COM3 utilize standard 9-pin male D-sub connectors. RS-232 ports
are protected with LCDA12C devices to ±4KV ESD. RS-485 port COM3 is protected with
LCDA12C and LCDA05 devices to ±4KV ESD.

CPU Module I/OB Connector P2
CPU Module I/O Bus connector P2 provides a 36-pin interface between slot #2 (P3) of the
Backplane PCB and the CPU Module. Separate data, address and control buffers provide
access to the I/O bus which in turn provides up to 14 slots of memory mapped I/O Modules.
The CPU Module interface to the I/O Modules is through a set of buffers and transceivers
that are capable of driving up to fourteen I/O Modules.

CPU Module/System Controller Module Interface Connector (P3)
CPU Module/System Controller Module Interface connector (P3) provides a 44-pin interface
between slot #2 (P2) of the Backplane PCB and the CPU Module. The SCM provides:

- a wide input range Vin to 3.3V DC to DC Converter
- 1200 Millisecond good power detection
- Vin out of Spec. detection
- LED Status indication

1.3.2.2 CPU Memory

Boot/downloader FLASH
Boot/download code is contained in a single 512Kbytes uniform sector FLASH IC. This
device resides on the local bus, operates at 3.3V and is configured for 8-bit access. 4-
Position DIP-Switch SW1's position 3 allows start-up menu options to be displayed or boot-
up from system FLASH. If SW1-3 is closed when a reset occurs, the boot-up code will cause
a recovery menu to be sent out the COM1 serial port to a terminal program running on an
external host computer. *Note: Recovery Mode will also be initiated if SCM Switch SW1
positions 1 and 2 are both set* **OPEN (Right)** *or* **CLOSED (Left)** *when a reset occurs.*

FLASH Memory
The base version of the CPU Module has 8Mbytes of 3.3V, simultaneous read/write (DL)
FLASH memory. Each CPU Board contains two 48-pin TSOP sites that will each accept 4
or 8 Mbytes of 3.3V, (DL) FLASH IC, for a total of 4 or 8 Mbytes of memory. FLASH

memory is 32-bits wide. System Firmware and the Boot Project are stored here. No hardware write protection is provided for the FLASH array.

System Memory (SRAM)
The base version of the CPU Module has 2Mbytes of soldered-down static RAM, implemented with two 512K x 16 asynchronous SRAMs that are configured as a 512K x 32-bit array. During power loss periods, SRAM is placed into data retention mode (powered by a backup 3.0V lithium battery). SRAMs operate at 3.3V and are packaged in 44-pin TSOPs. Critical system information that must be retained during power outages or when the system has been disabled for maintenance is stored here. Data includes: Last states of all I/O, historical data, retain variables and pending alarm messages not yet reported. The SRAM supports 32-bit accesses and is connected to the GP bus.

1.3.2.3 CPU Module Configuration Jumpers

ControlWave **EFM** CPU Modules are provided with three User Configuration Jumpers that function as follows:

- JP1 - Battery Backup Disable Jumper - On the Battery Backup Board - When JP1 is removed, the CPU Module backup battery is disabled.
- JP4 - Status LEDs Disable Jumper - When JP4 is removed, the Status LEDs and the Idle LED on the System Controller Module (SCM) are disabled.
- JP7 - Comm. port Status LEDs Disable Jumper - When JP7 is removed the CPU Comm. Port Status LEDs are disabled.

1.3.2.4 CPU Module Configuration Switches

Three user configurable DIP-Switches are provided on the CPU Board; eight-bit DIP-Switch SW2 is provided for user configuration settings while four-bit DIP-Switch SW1 provides forced recovery functions. Eight-bit DIP-Switch SW3 provides loopback, termination control, and receiver bias settings for the RS-485 port (COM3).

Table 1-2 - Assignment of CPU Bd. Switch SW2 - User Configurations

Switch	Function	Setting
SW2-1	Watchdog Enable	ON = Watchdog circuit is enabled OFF = Watchdog circuit is disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches or FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump via Mode Switch (SW1) on SCM
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-8	Enable WINDIAG	ON = Don't allow WINDIAG to run test OFF = Disable boot project and allow WINDIAG to run test

 * = Boot PROM version 4.7 or higher and System PROM version 4.7 or higher

Table 1-3 - Assignment of CPU Bd. Switch SW1
Force Recovery Mode

Switch	Function	Setting
SW1-3	Force Recovery Mode	ON = Force recovery mode (via CW Console) OFF = Recovery mode disabled

Table 1-4 - Assignment of CPU Module Switch SW3
COM3 - Loopback & Termination Control

Switch	RS-485 Function	Setting
SW3-1	TX+ to RX+ Loopback	ON - Only for Diagnostics
SW3-2	TX- to RX- Loopback	ON - Only for Diagnostics
SW3-3	100 Ohm RX+ Termination	ON - End Nodes Only
SW3-4	100 Ohm RX- Termination	ON - End Nodes Only
SW3-7	RX+ Bias (End Node)	ON - End Nodes Only
SW3-8	RX- Bias (End Node)	ON - End Nodes Only

1.3.2.5 CPU Module LEDs

ControlWave **EFM** CPU Modules have six (6) LEDs on the CPU Board. Units equipped with an optional Ethernet Port have two (2) additional LEDs (situated on the Ethernet RJ-45 connector). Table 1-5 provides CPU Module LED assignments. An ON LED indicates an associated transmit (TX) or receive (RX) activity.

Table 1-5 - Assignment of CPU Module LEDs

LED Ref.	LED Function
C1	TX COM1
C1	RX COM1
C2	TX COM2
C2	RX COM2
C3	TX COM3
C3	RX COM3

1.3.3 System Controller Module (SCM)

The System Controller Module (SCM) plugs into the system's Backplane Board slot #1 (Connector P1 - a 44-pin female non-keyed header). The front of the SCM contains two pluggable terminal blocks for external, input power (TB1) and RTD (TB2 - future) connections. An RJ-45 connector provides the interface to a remote Display/Keypad Assembly. Two red LEDs, visible through the front panel, provide for the following status conditions when lit: WD (Indicates a Watchdog condition has been detected) & IDLE (Indicates that the CPU has free time at the end of its execution cycle. Normally, it should be ON most of the time. When the Idle LED is OFF, it indicates that the CPU has no free time, and may be overloaded). Six status LEDs provide run time status codes.

SCMs contain a DC to DC power supply that generates a +3.3Vdc supply for the entire unit, i.e., the CPU and various I/O Modules that plug into the Backplane Board. Also contained on the SCM is the sequencer circuit that monitors the external power supply as well as the logic supplies (3.3Vdc and 1.8Vdc on the CPU Board). The sequencer circuit has a reset/early power fail warning controller that is utilized by the CPU Board to generate a master reset (MRESET) to the rest of the system and to generate a power fail interrupt to the CPU.

The power supply operates from +4.5/+4.9 to +16Vdc or +9.6/10.3 to +16Vdc with the nominal input supply configuration (+6V or +12V) user configured via on-board jumpers. A supervisory circuit monitors the incoming power and the supply voltages. The isolated supplies are shut down when the incoming voltage drops below +4.5V for a +6V system or +9.6V, for a +12V system.

An external battery monitor is composed of an Analog to Digital Converter (ADC) and interface circuitry.
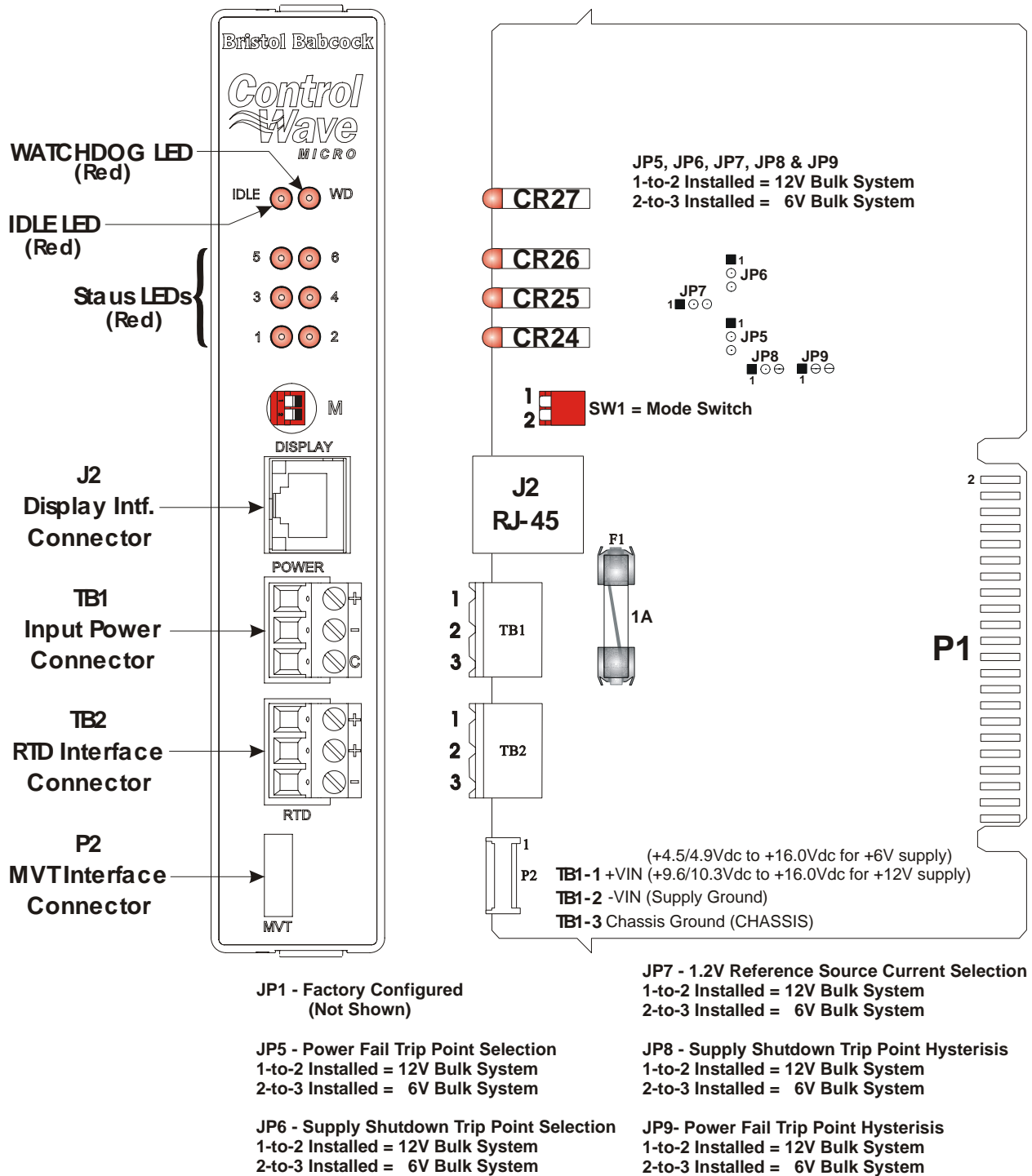
Figure 1-6 - Control Wave **EFM System Controller Module**

1.3.3.1 SCM Mode Switch

SCM Module's Mode Switch (SW1), is a 2-position piano type DIP-Switch that is utilized for recovery mode and core updump operations (see Sections 2.4.3 and 3.6)

1.3.3.2 SCM Board Fuse

The SCM is fused to protect the entire system. 5x20mm Slow Blow Fuse F1 is rated at 1A.

1.3.3.3 SCM Board Connectors

Connectors TB1, TB2, J1, J2 and P2 function as described below.

SCM Bd. Terminal Block Connector TB1
TB1 provides 3 input connections for bulk power:

TB1-1 = +VIN (+4.5/4.9 to +16.0V dc for +6Vdc supply)
$\qquad$ (+9.6/10.3V to +16V dc for +12Vdc supply)
TB1-2 = -VIN (Supply Ground - PSGND)
TB1-3 = Chassis Ground - CHASSIS ($\stackrel{\perp}{=}$)

SCM Bd. Terminal Block Connector TB2
TB2 provides 3 connections for a 100-ohm platinum bulb (DIN 43760 curve) RTD:

TB2-1 = RTD + (Sense or Excitation)
TB2-2 = RTD + (Sense or Excitation)
TB2-3 = RTD – (Return)

SCM Bd. Connector P2
P2 is an 8-pin non-keyed male in-line connector that mates with the Multivariable Transducers (MVT) Interface Cable's female connector.

SCM Bd. Connector P1
P1 is a 44-pin non-keyed male card-edge connector that mates with Backplane connector P1 (slot #1) and interfaces Power, Ground, Status and Control signals to the system.

SCM Bd. Connector J2
RJ-45 Connector J2 provides an interface to a remote Display/Keypad Assembly.

1.3.3.4 SCM Jumpers

ControlWave **EFM** SCM Modules are provided with six User Configuration Jumpers (see Figure 1-6 for jumper functionality).

1.3.3.5 SCM LEDs

In addition to WATCHDOG and IDLE LEDs, the SCM contains six status LEDs, which are driven by a status register on the CPU Module. These LEDs are visible through the front panel and provide run time status codes (see Section 2.4.2 or Section 3.3.2).

1.3.4 ControlWave EFM Backplanes

4-Slot or 8-Slot **Control**Wave **EFM** Backplanes provide for the electrical interconnection of the System Controller Module (SCM), CPU Module, Expansion Communication Modules (ECOMs) and/or I/O Modules. One or two Expansion Comm. Modules may be substituted for I/O Modules in Backplane slots 3 & 4. Backplane module slot connections that support Expansion Comm. Modules (slots 3 & 4) or I/O Modules (slots 3 through 8) are implemented via 36-pin female Headers.

The main complement of signals on the Backplane, implement an I/O bus for data transfer between the CPU and I/O Modules. *Note: I/O Modules are Non Interrupt Capable.*

+3.3Vdc and GND from the SCM are connected to the CPU. All I/O Module slot positions receive +3.3Vdc and GND. Additionally, the SCM supplies switched field power (FIELDVOUT) to all I/O Module slots. The power supply sequencer circuit (within the SCM) provides POWERGOOD, POWERFAIL, VIN100M and PFDLYCLK signals to the CPU thus providing properly timed early warning of low input or supply voltages followed by a CPU reset to support the WARM START CPU function.

4-Slot Base Backplane

P1 = PSSM Module Connector (BP Slot #1)
P2 = CPU Module - PSSQ/CPU Connector (BP Slot #2)
P3 = CPU Module - I/O Bus Interface Connector (BP Slot #2)
P4 = Exp. Comm. Module #1 or I/O Module #1 (BP Slot #3)
P5 = Exp. Comm. Module #2 or I/O Module #2 (BP Slot #4)
P10 = Exp. Backplane Connector

Note: Slots 1 through 4 Identical to 4-Slot Base Backplane

8-Slot Base Backplane

P1 = PSSM Module (BP Slot #1)
P2 = CPU Module - PSSQ/CPU (BP Slot #2)
P3 = CPU Module - I/O Bus (BP Slot #2)
P4 = Exp. Comm. Module #1 or I/O Module #1 (BP Slot #3)
P5 = Exp. Comm. Module #2 or I/O Module #2 (BP Slot #4)
P6 = I/O Module #3 (BP Slot #5)
P7 = I/O Module #4 (BP Slot #6)
P8 = I/O Module #5 (BP Slot #7)
P9 = I/O Module #6 (BP Slot #8)
P10 = Exp. Backplane Connector

Figure 1-7 - Backplane Board Diagram

1.3.5 ControlWave EFM Base Assembly Chassis

A Gold Irridite Aluminum Chassis supports the **Control**Wave **EFM** Backplane PCBs and the modules that comprise the system (see Figs. 1-3 & 4-3). Dimensions are provided in Section 4 of this manual (see Figures 4-3 and 4-4 for 4-Slot and 8-Slot Chassis, respectively).

The unit's Base Assembly Chassis is mounted to the Fabrication Panel inside the Hoffman Enclosure. **Control**Wave **EFM** Chassis' contain a Ground Lug that accommodates up to a #4 AWG Ground Wire. Grounding the unit is accomplished by connecting a ground wire between the Ground Lug and a known good Earth Ground.

1.3.6 **Control**Wave **EFM I/O Modules**

Five unique I/O Modules are available factory configured for either local or remote field device wiring termination. I/O Modules provide Configuration Jumpers that accommodate individual field I/O user configuration. Terminations are pluggable and accept a maximum wire size of 14 gauge. All I/O have surge protection that meets C37.90-1978 and IEC 801-5 specifications. Each I/O Module is connected to the **Control**Wave **EFM** Back-plane via a 36-pin male card-edge connector. With the exception of the Mixed Input/Output Module, all I/O Modules are provided with two 10-point Terminal Block Assemblies (for local termination) or two 14-pin Mass Termination Headers (for remote termination). Mixed I/O Modules are provided with two 10-point Terminal Block Assemblies (for local termination). A brief overview of each I/O Module type is provided below. Specifications are covered in Section 4.4.
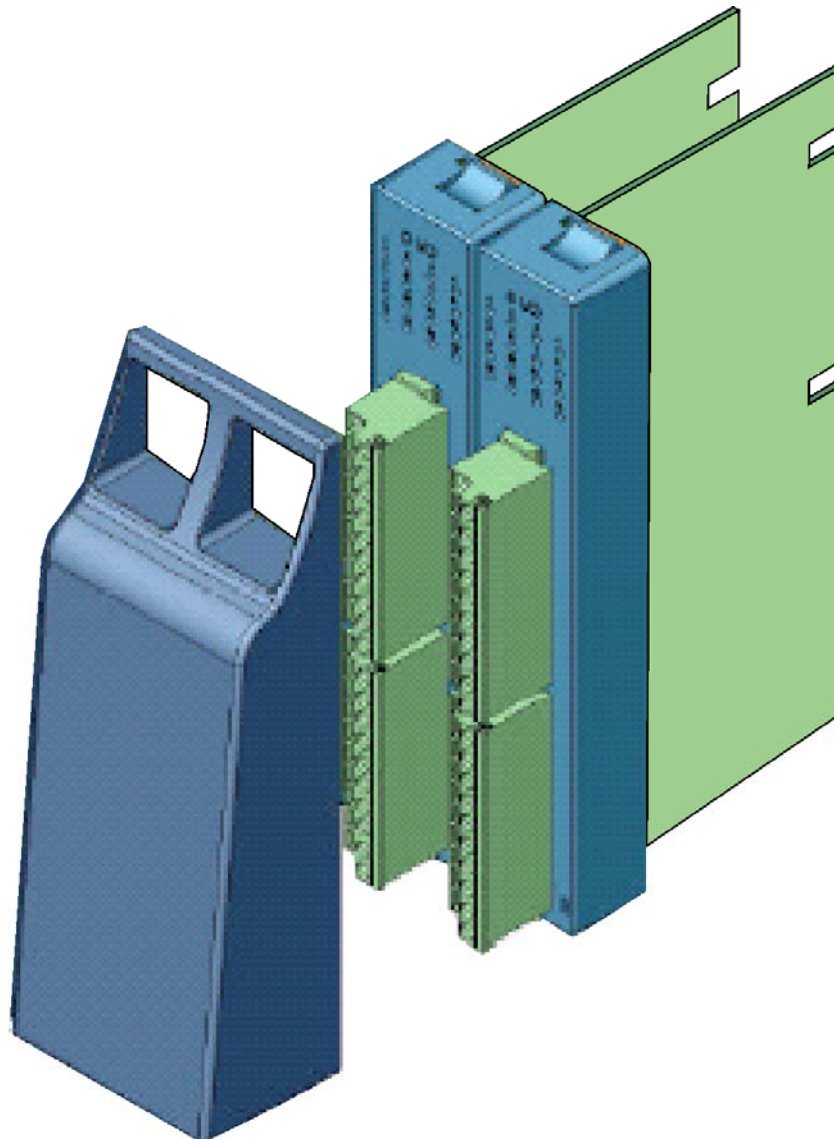
Figure 1-8 - Two Control Wave **EFM I/O Modules (with Bezel)**

1.3.6.1 Non-isolated Analog I/O & Analog Input Modules (also see Section 2.3.4.5)

ControlWave **EFM** AI/O Modules provide 6 Analog Inputs and optionally 2 Analog Outputs. All Analog Inputs are externally sourced, single-ended and individually Jumper configurable for either 4-20mA or 1-5Vdc. Analog Outputs are externally sourced and are individually Jumper configurable for 4-20 mA or 1-5 Vdc. 30Vdc Transorbs provide surge suppression between each signal and ground. Analog Input Modules are identical to AI/O Modules but have a depopulated AO section.

1.3.6.2 Non-isolated Digital Input/Output Module (also see Section 2.3.4.4)

ControlWave **EFM** DI/O Modules provide 12 Digital Inputs and 4 Digital Outputs. All Digital Inputs support dry contact inputs internally sourced from the 3.3 Vdc supply and a jumper selectable input current range of 60 uA (for low power applications) or 2 mA (for in-plant noise immunity). 15 millisecond input filtering protects against contact bounce. Digital Outputs have a 30 Vdc operating range and are driven by Open Drain FETs that provide 100 mA (max) at 30Vdc. DI/O Modules support optional Status Indication with an LED per I/O point**.** 31Vdc Transorbs provide surge suppression between each signal and ground.

1.3.6.3 Non-isolated High Speed Counter Input Module (also see Section 2.3.4.6)

High Speed Counter Input (HSCI) Modules provide a total of 4 internally sourced inputs that provide 2mA or 200uA (low power) input signals. Signal conditioning is provided by a debounce circuit for a relay contact input source, followed by a one-shot pulse circuit that generates a 65usec ±10% pulse. The signal conditioning circuitry also provides 20 micro-second filtering. All Input circuits have surge suppression. HSC inputs can be individually configured for dry contact or externally generated signal inputs. HSCI Modules are provided with thirteen (13) user Configuration Jumpers that accommodate LED enable/disable functionality, individual HSC input debounce enable/disable and individual HSC 200uA or 2mA source for field connections.

1.3.6.4 Non-isolated Mixed Input/Output Module (also see Section 2.3.4.7)

Non-isolated Mixed I/O Modules provide a total of 6 individually field configurable Digital Inputs/Outputs, 4 Analog Inputs, 2 High Speed Counter Inputs and 1 optional Analog Output. All I/O circuitry is similar to those utilized on the I/O Modules discussed in sections 1.3.6.1 through 1.3.6.3.

1.3.7 ControlWave EFM Expansion Communications Modules

Expansion Comm. Modules provide two additional serial communications ports and op-tionally the choice of a piggy-backed dial-line modem or piggy-backed 900 MHz Spread Spectrum radio (or both). Both serial communication ports support speeds of up to 115.2 KB. The top Comm. port (labeled C1) supports RS-232 operation while the second one (labeled C2) supports RS-485 operation. The RS-485 Port can optionally be ordered with isolation to 500Vdc. Up to two Exp. Comm. modules may be installed (backplane slots 3 and 4).
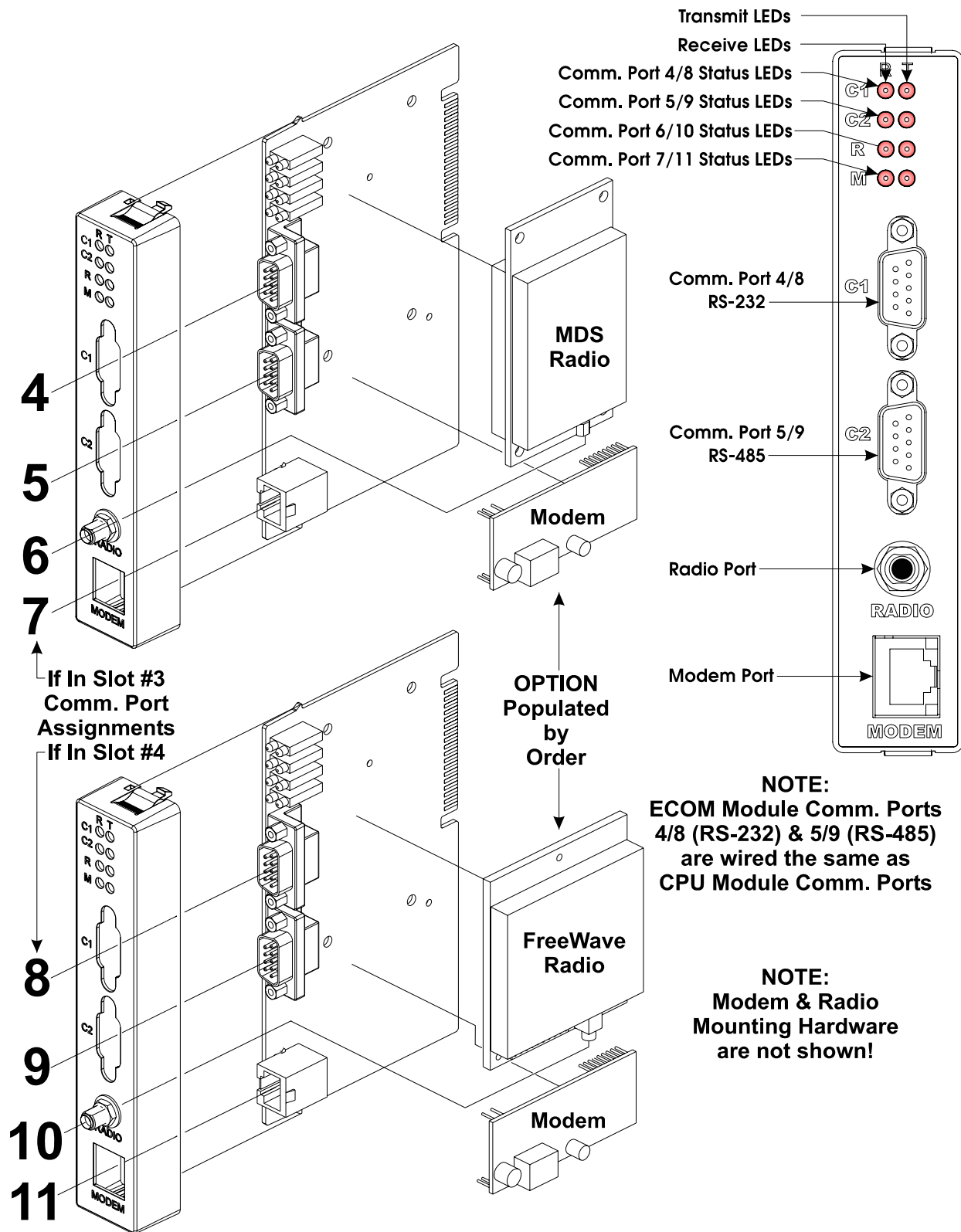
Figure 1-9 - Control Wave **EFM Communications Module**

1.3.8 Internal Mounting Brackets

Internal mounting brackets that support the various system components, such as the Battery, **Control**Wave **EFM** Base Assembly, etc., are mounted on the 'Fabrication Panel,' which in turn is secured to the inner rear wall of the enclosure. An External radio or

modem will mount via a Radio/Modem Mounting Bracket (beneath the Battery Mounting Bracket on units equipped with a 4-Slot Chassis)..

1.3.9 Multivariable Transducer

The Multivariable Transducer (MVT) pressure assembly is connected to the process manifold either directly or by tubing. In the body of the transducer, metal diaphragms are exposed to the gas. Solid-state strain gauge sensors in the neck of the transducer measure the pressure applied to the diaphragms and produce proportional electrical signals.

The neck of the Multivariable Transducer extends into the bottom of the enclosure, with the body of the transducer outside the enclosure. The MVT cable connector is factory mated with System Controller Module connector P2.

1.3.10 Power Distribution Board

When an external power source is used to provide bulk power to the unit, power is routed to various optional items through a Power Distribution Board. In this case, options such as the 21V Power Supply, Digital to Relay I/O Board or an external radio or modem, will require the use of the Power Distribution Board. Power Distribution Boards, Digital to Relay I/O Boards and the 21V Power Supply Boards are mounted to the inside of the enclosure in question using a Snap Track and Dual PCB Mounting Bracket.
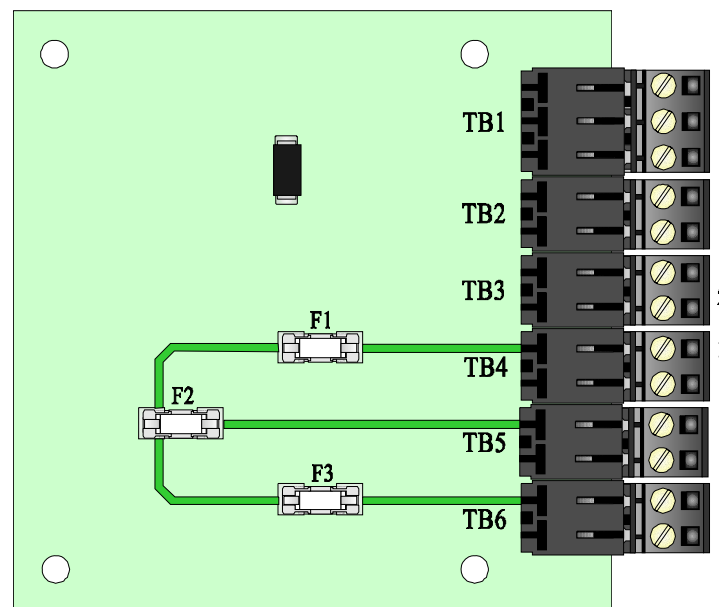
Figure 1-10 - Power Distribution Board

1.3.11 Digital to Relay I/O Option

The Digital To Relay I/O Board (see Figure 1-11) converts one or two Discrete Output Signals from open drain MOSFET levels to Form C relay output signal using Solid State Relay (SSR) logic.

Each Discrete Output can be converted to Form C relay output signals which can be configured for opposite or identical conditions, i.e., both Normally Open (NO) or Normally Closed (NC) or one Normally Open with the other normally Closed.
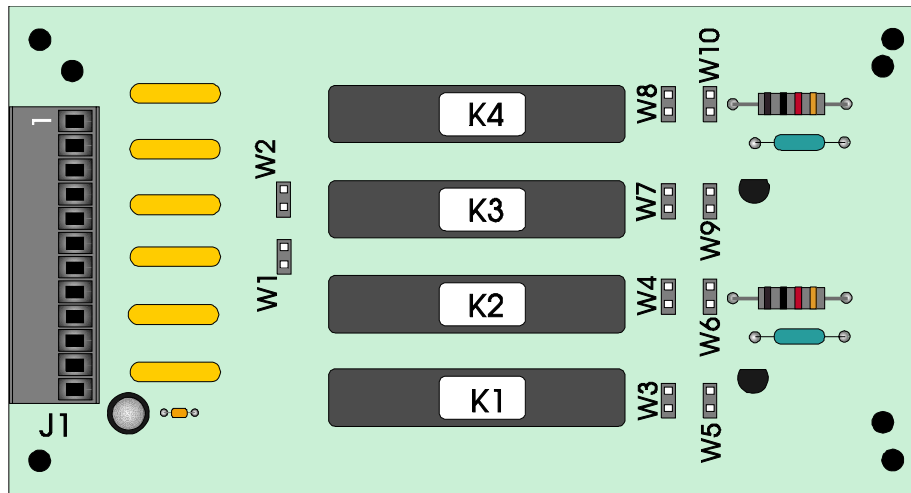
Figure 1-11 - Digital To Relay I/O Board

1.3.12 21V Power Supply Option

The 21V Power Supply is a continuous mode boost switching type power supply. It is based upon a low power, low noise circuit that produces 21 Volts from a 12V input. Power shutdown is not an option with this unit since it employs a Boost circuit; therefore, the 21V Power Supply must be powered continuously.
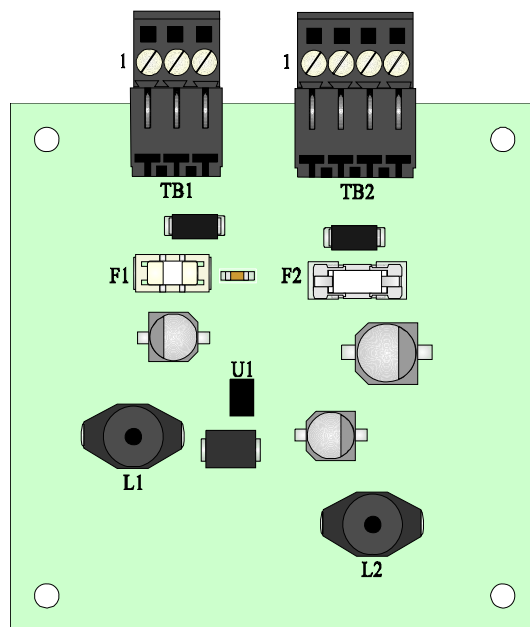
Figure 1-12 - 21V Power Supply Board

The 21V Power Supply is mainly used in conjunction with Temperature and Pressure Transmitters which require a higher than +12V but lower than 21.4V (± .8V) input supply to operate.

1.3.13 Power System

Power may be provided by a rechargeable 12V, 33AH Lead Acid Battery used in conjunction with either a 30 Watt or 40 Watt Solar Panel or power may be externally supplied.

Solar panels mount to a 2" pipe and can be swiveled for optimum alignment with the sun and their tilt angle is adjustable for maximum performance to accommodate the latitude of the installation site. Solar panel wires enter the unit through a liquid tight conduit fitting on the bottom of the enclosure. Internally the solar panel wires connect directly to the rechargeable battery - PWR (red wire) and GND (black wire) terminals.

1.3.14 RTD Probe

SCM Connector TB2 provides connection to a 100-ohm platinum bulb (using the DIN 43760 curve). The common three-wire configuration is accommodated. In this configuration, the return lead connects to the RTD- terminal while the two junction leads (Sense and Excitation) connect to the RTD+ terminals.

1.3.15 External Radio/Modem

In addition to or in lieu of an internal modem/radio an external modem or spread spectrum radio may be factory installed within the enclosure. A listing of modem and radios is provided in the Table Of Contents under the topic <u>REFERENCED OEM MANUALS</u>.

1.4 FIELD WIRING

ControlWave **EFM** electronic flow meters support connection to external field devices through its field wiring terminals on the System Controller Module and the various I/O Modules. In some cases a Power Distribution Board is provided and it may be connected to an external DC Power Supply or Source (such as a Solar Panel, user supplied - nominally 6 or 12Vdc battery) or a user supplied 4.5 to 16Vdc power supply. Connections to the following types of external devices may be made:

- RTD
- Analog Inputs (AIs)
- Digital Inputs (DIs)
- Digital Outputs (DOs)
- Relays
- Pulse Inputs (HSCs)
- Analog Outputs (AOs)
- Battery/Power Supply/Solar Panel
- Communications (RS-232 and RS-485)

1.5 FUNCTIONS

ControlWave **EFM** can come with or without a base application program that satisfies API 21.1 requirements for a meter station using up to four meter runs. Using **Control**Wave Designer, the user can readily modify this load to add or subtract functions, increase the number of runs, etc. An overview of the base application load is provided below.

- Uses pre-configured web pages for user readings, configuration and maintenance web pages can be modified and new pages configured to work with a modified application load
- Application load is object oriented
- Standard configuration is a four-run station
- Each run can be orifice, turbine or ultrasonic meter type
- Flow calculations include the following:
- AGA3-1985/NX-19
- AGA3-1992 with selectable AGA8 Gross or AGA8 Detail
- AGA7/NX-19

- AGA7 with selectable AGA8 Gross or AGA8 Detail
- Auto Adjust AGA7/NX-19
- Auto Adjust AGA7 with selectable AGA8 Gross or AGA8 Detail
- Includes run switching
- Includes an auto-selector, PID flow/pressure control algorithm per run or per station
- Interfaces to a chromatograph and provides energy throughput as well as composition information (requires the optional Expansion Communications Module)
- Resides on a BSAP SCADA network
- Supports samplers and odorizers
- Provides audit trail and archives
- Includes a nominations function
- Allows the user to select engineering units, including English and metric

The primary function of the **Control**Wave **EFM** is to measure the flow of natural gas in accordance with API (American Petroleum Institute) and AGA (American Gas Association) standards. Items below implement and supplement the primary function:

·	Data acquisition	(see Section 1.5.1)
·	Flow calculations	(see Section 1.5.2)
·	Data archives	(see Section 1.5.3)
·	Audit trail archives	(see Section 1.5.3.4)
·	Local display	(see Section 1.5.4)
·	Communications	(see Section 1.5.5)
·	Control outputs	(see Section 1.5.6)
·	Status inputs	(see Section 1.5.6)
·	Self test and diagnostics	(see Section 1.5.7)

1.5.1 Data Acquisition

The process inputs used by the **Control**Wave **EFM** are static pressure, differential pressure, and temperature for orifice measurement, or static pressure, temperature, and frequency input for positive displacement (PD), turbine, or ultrasonic meters. Static pressure and differential pressure may be obtained from the Multivariable Transducer connected to the **Control**Wave **EFM** System Controller Module (SCM). The inputs may also be derived from external smart Multivariable Transmitters using either the BSAP or MODBUS protocols. Alternatively, the inputs may be obtained via the local I/O Modules using analog transmitters. The standard **Control**Wave **EFM** application program allows any combination of inputs to be selected, for up to four runs of measurement.

Regardless of the operating mode or the calculation interval, the **Control**Wave **EFM** acquires samples as follows:

a. Differential pressure once per second
b. Static pressure once per second
c. Flowing temperature once per second
d. All self-test and compensation values at intervals of 4 seconds or less

1.5.2 Flow and Volume Calculations

The **Control**Wave **EFM** performs a complete flow calculation using the process variables every second. Each calculation includes instantaneous rate according to API 14.3, compressibility according to AGA 8 Detail or Gross method, and updates of all volumes,

totals, and archive averages. The user can select AGA3/NX-19 (1985), AGA3/AGA8, AGA7/NX-19 or AGA7/AGA8.

1.5.2.1 Flow Rate and Flow Time Calculations (AGA3)

For orifice flow measurement, the differential pressure value is compared to a flow cutoff value every second. If the differential pressure is less than the flow cutoff value, flow is considered to be zero for that second. Hourly and Daily flow time is defined to be the number of seconds for which the differential pressure exceeded the cutoff value for the period.

The values for static and differential pressure, temperature, and flow extensions are used as inputs to the flow equations. Users may select API 14.3 (AGA3, 1992) and AGA8 calculations, with compressibility being calculated according to AGA Report No. 8, 1992 (with 1993 errata). Both the DETAIL method and the two GROSS methods of characterization described in AGA8 are supported. Users may also select the AGA3, 1995 and NX-19 flow equations to calculate the rate of flow.

1.5.2.2 Flow Rate Calculations and Flow Time Accumulations (AGA7)

When using PD meters, turbine meters or ultrasonic meters, the flow rate is calculated by applying the correction factor computed by the AGA7 calculations to the frequency of the input pulses. When the frequency drops below 1 Hz, the flow rate estimate is set to zero; however, volume calculations are still accumulated. The flow time recorded is the time for which the flow rate is non-zero.

1.5.2.3 Extension Calculation and Analog Averaging

For orifice meters, a flow extension is calculated every second. The extension is the square root of the product of the absolute upstream static pressure times the differential pressure. This extension is used in the flow rate calculation. When there is no flow, arithmetic averages of static pressure and temperature are reported. This allows monitoring of static pressure and temperature during shut-in periods.

1.5.2.3.1 Energy Calculation

The **Control**Wave **EFM** offers the option of using a fixed volumetric heating value or calculating the energy content of the gas according to AGA Report No. 5.

1.5.2.3.2 Volume and Energy Integration

Volume and energy are each integrated and accumulated at the end of every calculation cycle. The volume for a cycle is the calculated rate multiplied by the flow time for that cycle. The energy for a cycle is calculated by multiplying the volume at <u>BASE</u> conditions by the heating value.

1.5.2.4 Downstream Pressure Tap

The multivariable transducer typically measures static pressure from an integral tap on the upstream, high-pressure leg of the differential pressure connection. Static pressure can be measured at the downstream pressure tap, with the measurement taken from the low-pressure side to the high-pressure side. In this installation, the differential signal from the transducer is negative. If while using the integral smart Multivariable Transmitter (MVT)

or an external MVT, the user selects the downstream tap location during MVT configuration, the MVT firmware changes the sign of the differential pressure to provide a positive DP value.

1.5.3 Archives

The **Control**Wave **EFM** stores two distinct types of archive data. The first type is Audit Trail data, which is a recording of the various events and alarms that have an impact on the calculated and reported rates and volumes. The second type is historical data, which includes records of rates and volumes and other signals over time. When an archive log becomes full, new entries replace the oldest entries in the log.

Where feasible, both forms of archive data conform to the requirements of the API Chapter 21 (the Committee on Gas Measurement's EFM document). Specifically, the averages of the process variables stored in the data archive are for flowing periods, appropriate to their usage in the equations, and any gas-related parameter designated an event that is changed by an operator either remotely or locally causes an entry in the audit log.

The **Control**Wave **EFM** supports the "breaking" of a log period when an operator-entered parameter is changed. When this occurs, the log period in process is closed out, a log is made, and a new log is begun. This feature is disabled by default and may be enabled by the operator. *Note: To prevent several very short logs from being created due to a series of successive configuration changes, the* **Control**Wave **EFM** *will not create a log which contains less than 60 seconds (flowing or otherwise) of data. Therefore if a user enters 15 configuration changes over a 2minute period, the log will only be broken twice.*

1.5.3.1 Hourly Historical Data Log

The Hourly Data Log holds one record for every contract hour. Hourly logs hold 840 entries or 35 days; this ensures that the previous period of hourly data is always resident in **Control**Wave **EFM** FLASH memory.

The following items are stored in the Hourly Data Log:

   · Corrected Volume
   · Uncorrected Volume
   · Accumulated Energy
   · Average Static Pressure
   · Average Temperature
   · Average Differential Pressure
   · Average Specific Gravity
   · Average Heating Value
   · Flow Time
   · Uncorrected Count

Each log entry also contains the date and time. The **Control**Wave **EFM** has a Hourly Historical Log for each of four runs.

1.5.3.2 Daily Historical Data Log

The Daily Data Log holds one record for every contract day. The contract hour may be changed by the user. The daily log holds 62 entries; this ensures that the previous calendar month of daily data is always resident in **Control**Wave **EFM** FLASH memory.

The following items are stored in the Daily Data Log.

- Corrected Volume
- Uncorrected Volume
- Accumulated Energy
- Average Static Pressure
- Average Temperature
- Average Differential Pressure
- Average Specific Gravity
- Average Heating Value
- Flow Time
- Uncorrected Count

Each log entry also contains the date and time. The **Control**Wave **EFM** has a Daily Historical Log for each of four runs.

1.5.3.3 Periodic Historical Data Log

The periodic data log holds one record for every log interval. Log interval is 15 minutes. The Periodic Historical Data Log holds 1440 records, or four days of 15 minute data.

The following items are stored in the Periodic Historical Data Log:

- Flowing Differential Pressure
- Flowing Static Pressure
- Flowing Temperature
- Frequency

Each log entry also contains the date and time. The **Control**Wave **EFM** has a Periodic Historical Data Log for each of four runs.

1.5.3.4 Alarm and Event Storage

The **Control**Wave **EFM** keeps an Audit Trail Buffer capable of storing the most recent 500 Alarms and the most recent 500 Events. Internally, these buffers are maintained separately to prevent recurring alarms from overwriting configuration audit data. Externally, they are reported to the user as a single entity. Both operate in a circular fashion with new entries overwriting the oldest entry when the buffer is full.

The following circumstances cause an entry to be made in the Audit Trail Buffer:

- Any operator change to a **Control**Wave **EFM** configuration variable
- Any change in the state of a **Control**Wave **EFM** alarm signal
- A system restart
- Certain other system events

1.5.4 LCD Display

In normal operation, the display stays off after the unit is configured and placed in service. The operator may activate the display at any time by pressing the front panel button. When activated, the display scrolls through a list of current values. The list defaults to an appropriate set of values.

1.5.5 Communications

A **Control**Wave **EFM** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. Up to three communication ports are contained on the **Control**Wave **EFM** CPU Module and are designated as follows:

<u>CPU Module:</u>
COM1 - Port 1: CPU Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232
COM2 - Port 2: CPU Bd. J4, PC/AT 9-Pin Male D-Sub - RS-232
COM3 - Port 3: CPU Bd. J5, PC/AT 9-Pin Male D-Sub - RS-485 - Configured by SW3

A **Control**Wave **EFM** can support up to two optional Expansion Communications Modules, which can reside in slots 3 and 4 (ONLY), in lieu of I/O Modules. Each Expansion Communications Module contains two serial communications ports (one RS-232 and one RS-485), an optional built-in spread spectrum modem (radio) and an optional built-in 56KB PL/PSTN modem that are designated as follows:

<u>Expansion Communications Modules:</u>
COM4, COM5, COM6 & COM7 on first ECOM Bd., assigned to Base Chassis Slot #3
COM8, COM9, COM10 and COM11 on second ECOM Bd., assigned to Base Chassis Slot #4
COM4/8 - Port 1: ECOM Bd. J1, PC/AT 9-Pin Male D-Sub - Both RS-232
COM5/9 - Port 2: ECOM Bd. J2, PC/AT 9-Pin Male D-Sub - Both RS-485 - Configured by SW1 on ECOM Board
COM6/10 - Port 3: ECOM Bd. Piggy-back Radio Module (FreeWave or MDS TransNet Spread Spectrum Modem) Antenna connector provided
COM7/11 - Port 4: ECOM Bd. Piggy-back Modem Module (Multitech 56KB PL/PSTN Modem) RJ-11 connector provided

Note: These RS-485 Ports are optionally available with 500Vdc isolation.

Communication Ports COM1, COM2, COM3, COM4, COM5, COM8 and COM9 support serial asynchronous operation. Communication Ports COM1, COM2, COM4 and COM5 support RS-232 while COM3, COM5 and COM9 support RS-485 operation. Communication Ports COM4/8, COM5/9, COM6/10 and COM7/11 reside on optional Expansion Communications Modules (ECOM1/2). ECOM1 must reside in Base Chassis Backplane Slot #3 while ECOM2 must reside in Base Chassis Backplane Slot #4. ECOM Modules have one RS-232 Port and one RS-485 Port. Additionally, an ECOM Module may optionally contain a 56Kbaud PSTN Modem and/or a Spread Spectrum Modem (Radio). Any non-Ethernet communication ports can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software.

RS-232 Ports
An RS-232 interface supports Point to Point, half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave **EFM** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave **EFM** RS-232 ports utilize the "null modem" cable (Figure 2-12A) to interconnect with other devices such as a PC, printer, another **Control**Wave **EFM** or other **Control**Wave series unit when the **Control**Wave **EFM** is communicating using the full-duplex PPP protocol.

RS-485 Ports
ControlWave **EFM** can use an RS-485 communication port for local network communications to multiple nodes up to 4000 feet away. Essentially, the master and the first

slave transmit and receive data on opposite lines; all slaves (from the first to the "nth") are paralleled (daisy chained) across the same lines. The master node should be wired to one end of the RS-485 cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported.*

From the factory COM1 defaults to 115.2 kbd using the BSAP Protocol. The remaining serial communication ports, i.e., COM2 through COM5 default as follows:

COM2 – BSAP Slave @ 9600 Baud
COM3 – BSAP Master @ 9600 Baud (for use with Bristol Babcock 3808 MVT Transmitters)
*COM4 – MODBUS Master @ 9600 Baud (for use with Daniel 2251 Chromatograph)
*COM5 – MODBUS Master @ 9600 Baud (for use with Rosemount Transmitters)
* COM4 and COM5 are situated on an optional Expansion Comm. Module.

1.5.5.1 BSAP Message Support

The **Control**Wave **EFM** supports the same subset of BSAP messages as the other **Control**Wave products.

1.5.6 Discrete and Analog I/O EFM Functionality

ControlWave **EFM** electronic flow meters may be equipped with a variety of I/O Modules (see Sections 1.3.6 through 1.3.6.4). While using the standard application program, inputs and outputs required for measurement and control are mapped to the application using the configuration Web pages. Analog Alarm limits for variables required by the standard application program are defined via the configuration Web pages. Discrete Input alarms associated with the standard application program can be enabled or disabled on a per point basis via the configuration Web pages. Control algorithms (flow control, sampler control, odorant control, etc.) are selected via the configuration Web pages.

1.5.6.1 Flow Rate Control - DDC (jog control) using PID

When the user configures the **Control**Wave **EFM** to perform flow rate control, the two digital output signals are wired to the Open and Close inputs of a controller. The **Control**Wave **EFM** uses a Proportional/Integral/Derivative (PID) algorithm to cause the measured rate of flow to match a user-entered setpoint. When the flow rate is below the setpoint, the Open output is pulsed. When the flow rate is above the setpoint, the Close output is pulsed. The PID equation calculates the duration of the Open or Close pulse. The minimum pulse duration is 1.0 seconds. The user changeable parameters are:

- Flow Setpoint in MSCFH
- Deadband in % of setpoint
- Proportional Gain
- Integral Time in repeats/minute
- Derivative Time in seconds
- Valve Travel Time (full close to full open)
- Process Control Limiting
- Pressure Override Limits

The flow control algorithm runs once per second.

1.5.6.2 Pulse Output for External Totalizer or Sampler

When the **Control**Wave **EFM** is configured to provide a pulse output based on volume, the operator provides a control volume and pulse duration. After each calculation cycle, an internal volume accumulator is compared to the control volume. If the accumulator exceeds the control volume then a pulse is output and the accumulator is reduced by the volume represented by the pulse. The pulse output may be used to drive an external totalizer, odorizer, gas sampler, or similar device.

1.5.6.3 Nominations

The nomination function allows a user to establish a time period over which an accumulation count of volume or energy that is delivered during the period is monitored and compared to a configured 'nomination' value. When the nomination value is reached, the system will perform an action (such as opening or closing a valve). Prior to nomination being reached, the volume/energy will be compared to a configured alarm level and an alarm will be generated when the volume/energy reaches or exceeds the defined (specified) level.

1.5.7 Self Test & Diagnostics

The **Control**Wave **EFM** periodically runs a series of diagnostics to verify the operational status of various system components. The tests include transducer parameters, main and backup battery voltages, software sanity checks, and other indications of system health. An appropriate alarm is generated if any test fails.

Bristol, Inc's. WINDIAG program provides menu driven diagnostics that have been designed to assist a technician or Process Engineer in troubleshooting the various **Control**Wave **EFM** Modules (see Document D4041A).

Section 1A
PRODUCT FEATURES & OVERVIEW

1A.1 PRODUCT OVERVIEW

ControlWave® products have been designed and integrated as a highly adaptable, high performance Distributed Open Controller family with exceptional networking capability that provides a complete Process Automation Management Solution. **Control**Wave **EFM** electronic flow meters have been designed with an emphasis on providing high performance with low power consumption, scalability and modularity. **Control**Wave **EFM** Base Housings support up to 2 I/O or 6 I/O Modules (4-Slot and 8-Slot Housings respectively).

ControlWave **EFM** electronic flow meters have been designed as an ideal platform for remote site automation, measurement and data management within the oil & gas industry. **Control**Wave **EFM** units are extremely effective in Flow Computer, Process Controller or Remote Terminal Unit capacities as follows:

- API 21.1 EFM/Flow Computer application

ControlWave **EFM** units offer a cost effective and competitive match to all industry meters used in Electronic Flow Measurement and Flow Computer installations.

- For orifice and other differential meters, **Control**Wave **EFM** has been designed to integrate a DP/P/T, smart Multivariable Transducer with excellent per-formance over the full range of operating pressure and temperature conditions.
- For linear meters, such as turbine and ultrasonic meters, **Control**Wave **EFM** doesn't overlook the importance of pressure and temperature corrections and utilizes smart P/T circuitry to provide high accuracy over the full range of operating conditions.

- Process Controller or Remote Terminal Unit (RTU) applications

Process Controller and RTU applications don't suffer performance limitations of flow computers with expanded hardware. User configurable I/O Modules provide AI/O, DI/O and HSC functionality. Up to two Expansion Communication Modules (2 RS-232 & 1 RS-485 Port, each) can be added to a **Control**Wave **EFM**.

1A.1.1 Hardware Features

- Wide operating temperature range (-40 to 70°C)
- Nonincendive Class I, Div. 2 Hazardous Location approval & CE approval
- ARM Processor provides exceptional performance and low power consumption
- Standard three serial communication ports (Two RS-232 & One RS-485)
- Optional serial communication port expansion with built-in modem and radio options
- Mixed I/O Cards provide cost effective I/O for small RTU applications

1A.1.2 Firmware and Software Features

- Standard application load for up to four run, API 21.1 EFM operation
- Additional application loads (e.g. well automation with plunger lift control) are also available

- Full user programming environment, **Control**Wave Designer with ACCOL III, is available for modification of existing loads as well as creation of custom loads
- Full suite of function blocks for flow calculations, audit trail, historical archive/data management, communication, and process control is included.
- File management, including video images
- Fully supported by a complete HMI and network communication software suite: Bristol Babcock's OpenBSI

1A.2 PRODUCT FAMILY COMPATIBILITY

Not only is **Control**Wave **EFM** scalable, it is also compatible with Bristol Babcock's **Control**Wave family. **Control**Wave **EFM** is fully software-compatible with the original **Control**Wave, which provides greater I/O capacity.

1A.2.1 Open Standards for Programming, Network Config. and Communication

Only **Control**Wave brings the perfect combination of industry standards to minimize learning, engineering and implementation costs.

By adhering to such industry standards as Ethernet, TCP/IP, Microsoft Windows®, COM/DCOM, FTP, OLE and ActiveX, **Control**Wave is able to achieve the highest degree of openness in control system architecture and bring the optimal process efficiency and productivity needed to ensure a successful system implementation.

1A.2.2 **Control**Wave **Designer with ACCOL III**

To minimize your engineering and development time, we have adopted the international standard for PLC programming, IEC 61131-3. **Control**Wave Designer is a fully IEC 61131-3 compliant programming environment for the **Control**Wave family of products. **Control**Wave Designer includes all five IEC 61131-3 process languages for batch, continuous and discrete control. Function Block Diagram, Structured Text Sequential Function Chart, Ladder Logic Diagram and Instruction List.

ControlWave **Designer** includes an extensive library of more than 200 basic IEC 61131-3 functions and function blocks common to many IEC 61131-3 based products. These include:

- Flip-flops, Counters & Timers
- Ladder diagram functions – coils and contacts, etc.
- Numerical, Arithmetic & Boolean functions – Sine, Cosine, Add, Sub, Square Root, And, Or, etc.
- Selection & Comparison – Min, Max, Greater than, Equal, Less than, etc.
- Type conversions – Integer to Real, Boolean to Word, etc.

1A.2.3 ACCOL III

In addition to the basic functions and function blocks, **Control**Wave Designer brings the benefit of over twenty years of SCADA and plant control experience in Bristol Babcock's ACCOL III function block library. ACCOL III includes over sixty function blocks valuable for use in oil & gas, water & waste and process measurement & control applications. Further, ACCOL III is designed to take full advantage of the significant features offered by **Control**Wave.

Briefly, this library includes function blocks for:

- Average, Compare, Totalize
- Scheduling & Sequencing
- PID & Lead/Lag
- AGA gas flow and liquids calculations
- File handling

In addition, **Control**Wave ensures data integrity, in the event of a communication interruption, by storing critical time-stamped alarm and historical data in the controller memory. This data is then securely retrieved when communication is restored.

1A.3 STANDARD APPLICATION PROGRAM

ControlWave **EFM** can come with or without a base, application program that satisfies API 21.1 requirements for a meter station using up to four meter runs. Using **Control**Wave Designer, the user can readily modify this load to add or subtract functions, increase the number of runs, etc.

Overview of the base, application load:

- Uses pre-configured web pages for user readings, configuration and maintenance-web pages can be modified and new pages configured to work with a modified application load
- Application load is object oriented
- Standard configuration is a four-run station
- Each run can be orifice, turbine or ultrasonic meter type
- Flow calculations include the following:
  - AGA3-1985/NX-19
  - AGA3-1992 with selectable AGA8 Gross or AGA8 Detail
  - AGA7/NX-19
  - AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Auto Adjust AGA7/NX-19
  - Auto Adjust AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Instromet Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Daniel Modbus AGA7 with selectable AGA8 Gross or AGA8 Detail
  - Includes run switching
  - Includes an auto-selector, PID flow/pressure control algorithm per run or per station
  - Interfaces to a chromatograph and provides energy throughput as well as composition information
  - Resides on a BSAP SCADA network
  - Supports samplers and odorizers
  - Provides audit trail and archives
  - Includes a nominations function
  - Allows the user to select engineering units, including English and metric

1A.3.1 OpenBSI - Simply Creative

OpenBSI (**O**pen **B**ristol **S**ystem **I**nterface) is a set of network setup, communication diagnostic, and data viewing utilities that provide access to both **Control**Wave and Network 3000 controllers and RTUs. OpenBSI is the only product available in the industry to bring such unique functionality and ease of use to the network level. At the core is the communication interface, written as a Windows communication server API through which

other client applications communicate with the Bristol networks. OpenBSI supports both serial BSAP protocol and Ethernet Internet Protocol communication to **Control**Wave and Network 3000 RTUs and controllers.

1A.3.2 OpenBSI Utilities

Above this communication layer are a group of applications known as OpenBSI Utilities. These client utilities communicate through the server to collect and manage data gathered from the network, generate files based on collected historical data, collect alarms, and monitor and control OpenBSI communications.

- Communication engine for PC applications
- Supports **Control**Wave and Network 3000 serial and IP protocols
- RS 232, Dial-line, cellular, radio, CDPD, satellite, and Ethernet connections
- Provides on-line download & signal variable changes
- Allows network configuration through NetView
- PC and Network communication diagnostics
- OPC Server for interfacing to most HMI software
- Harvester collects historical data on request or scheduled basis

NetView is the basic configuration and application interface for all network operations. NetView uses a tree structure for network graphical display in the Windows Explorer style. Network nodes can be added on-line by simply dragging the node Icon into the tree. This invokes a configuration Wizard simplifying network setup. Through the NetView Wizard, the necessary network parameters are entered for node and IP address, alarm and message routing, and network communication media. Once configured, selecting any node allows direct access to the common OpenBSI utilities to reprogram, download a new application to the node, review communication statistics, view real-time data through DataViewer, and edit controller/RTU properties.

Local Configuration Wizard allows local communication with any attached **C**ontrol-Wave controller or RTU to download system flashware upgrades, configure cold download parameters, and configure IP and soft-switch parameters.

DataView is an on-line utility used to collect and display several types of process data, including signal values, data array values, signal lists, and audit trail information.

Operators have the ability to alter signal values. Multiple DataView windows may be open simultaneously.

1A.3.3 Real-time ActiveX Controls

One of the many benefits OpenBSI brings to you is our use of open standards such as ActiveX Controls. ActiveX is another of the Microsoft standards, which allow plug and play with any ActiveX container, using Microsoft ActiveX container technology such as Visual Basic, HTML web pages, and Microsoft Excel.

The set of available ActiveX Controls provides the basic functions necessary to communicate and collect data from **Control**Waves.

1A.3.3.1 ActiveX Controls

- Security - 56-bit encryption - allows the user to sign on to the RTU
- Signal Value - displays signal values in various formats
- Comm. Statistics - works with a standard page that displays the RTU's communication statistics
- Configuration Info - works with a standard page that displays and allows the user to change RTU Configuration information
- Historical - Collect and view historical archive and audit files

The IP compliant **Control**Wave opens the door for owner controlled access via web pages. Any generic web page builder can be employed to create user defined pages to access **Control**Wave. The web pages are populated with these pre-configured ActiveX controls and are stored at the PC.

1A.3.3.2 Required Software

Microsoft Internet Explorer
Bristol Babcock ActiveX controls
OpenBSI LocalView or NetView

1A.3.4 Historical Data Collection

High Historical Data Integrity
The **Control**Wave Historical Data Collection system offers exceptional historical data integrity by providing time-stamped historical data storage in **Control**Wave flash memory. The historical data is collected, through OpenBSI, on a scheduled or demand basis and converted to .CSV and ODBC compliant file formats for use in spreadsheets and reports. If data is missed due to a communication failure, it is collected when the communication is reestablished and the PC historical database is back-filled with the missing data. This distributed historical database architecture provides the greatest data reliability and integrity during communication or PC failure.

Another important historical feature is the Audit storage and collection system. The Audit Trail is a file stored in **Control**Wave flash memory containing significant events and time-stamped alarms. The alarms stored in the Audit system provide a historical archive in addition to the real-time alarm reporting system.

This file is also collected through OpenBSI and presented as a text file in the PC. This functionality is extremely useful in providing an event trail during communication or PC downtime or other system problem.

- Archive Collection – collection and storage to disk of the **Control**Wave archive data
- Audit Collection - collection and storage to disk of the **Control**Wave audit data.
- Exports data files to third party, CSV & ODBC applications
- DDE compliant for use with other popular Windows applications

1A.3.5 OPC Server

With industry demand for open standards, **Control**Wave answers the call by embracing technologies that open the door for maximizing your efficiency and productivity. The OPC standard was developed by the OPC Foundation comprised of hardware and software suppliers from the process control community. OPC allows the engineer to select best in

class hardware and software with confidence in their interoperability. Our OpenBSI OPC Server was among the first to comply with the OPC Foundation alarm and event server specification.

- OPC Data Access 1.0a & 2.0 compatible
- Windows NT, 2000 & XP
- Compatible with both **Control**Wave and Network 3000 systems
- 32 bit multi-threading, multi-processor design
- Automatic database builder
- Integrated real-time data monitor
- Supports OPC Browse interface
- Supports both serial communications and IP Ethernet connections
- Supports COM/DCOM & OLE Automation
- Primary and Background polling scheme
- OPC Alarm & Event Server support

1A.4 **Control**Wave **OPEN NETWORK CONNECTIVITY**

By embracing the open system network technologies available through TCP/IP, Ethernet, OPC, and Microsoft DNA, as well as pseudo standards such as Modbus and Open Modbus, **Control**Wave can provide a total Process Automation Management Solution for in-plant LAN based networks and Wide Area Network SCADA systems.

With the exceptional connectivity provided by the **Control**Wave network, access to real-time data and operating conditions, historical data, maintenance and performance data are all available to the global network. **Control**Wave provides the needed information to the plant floor technician, operator, engineer, supervisor and corporate management, even external customers.

1A.4.1 **Communication Protocols**

Like all Bristol Babcock products, C**ontrol**Wave supports BSAP (Bristol Standard Asynchronous Protocol), Modbus, DF1, DNP 3 (serial) and serial ASCII as standard functions. These protocols are implemented in Flashware so no additional hardware is required to use any one or a combination of all protocols.

1A.4.1.1 **BSAP Protocol**

BSAP - All Bristol Babcock Network 3000 and **Control**Wave RTU and controller products support BSAP protocol. BSAP is widely accepted as providing exceptional data integrity and greatly simplifies communication between controllers. BSAP is provided with interfaces for Master/Slave, vertical networks and Client/Server, horizontal networks. In either case, variable lists are created in each controller that are easily passed from server to client or slave to master.

BSAP meets the definition of an industry-standard, open architecture protocol because if conforms to ISO standards 2629, 1745 and 2111, it is not proprietary in that Bristol Babcock does not charge a license fee and makes the protocol and documentation available to anyone.

While BSAP is an open protocol, the added functionality of the messages provide much more capability than is found other networks.

- Global time-synchronization
- Time-stamped Alarm reporting
- Historical archive data transfer
- Audit file transfer
- On-line program editing
- Diagnostics
- Communication statistics

1A.4.1.2 Modbus Protocol

Modbus - Modbus is often considered a de-facto standard protocol because broad usage as either the primary or a secondary offering in many measurement and control related products. Even with its common use, Modbus protocol actually has many variations. Consider Modbus RTU and Modbus ASCII, Master & Slave, Serial and TCP/IP Open Modbus. In addition there are consideration regarding supported function codes, floating point values and byte order. Bristol Babcock supports the following:

- Modbus serial and TCP/IP Open Modbus (Ethernet)
- Master and Slave
- Modbus RTU and ASCII
- Modes 1 - 7, 8, 15 & 16
- Integer and IEEE 4 byte floating point

1A.4.1.3 Generic Serial Interface

The Generic Serial Interface is a user programmable Master and Slave protocol used to send and receive messages typically with third party serial ASCII devices. This protocol can be used to interface with such devices and message boards, card readers and many measurement devices.

Section 2
INSTALLATION & OPERATION

2.1 INSTALLATION IN HAZARDOUS AREAS

Each **Control**Wave **EFM** electronic flow meter is furnished in a housing designed to meet the NEMA Type 3 specifications and to operate in a Class I, Division 2, Groups C & D environment with a nonincendive rating (see Appendix A).

1. Fabrication Panel	9. Local Comm. Port Connector
2. ControlWave MICRO EFM 4-Slot Base Assembly	10. RTD Probe (Conduit)
(from Left to Right - SCM, CPU & 2 I/O Modules)	11. External Radio (MDS - Transnet)
3. .5" Liquit Tight Conduit Fitting	12. Power Distribution Board
4. Multivariable Transducer (MVT)	13. Dual PCB Mounting Bracket
5. Rear Pipe Mounting Bracket (Qty. 2)	(with Snap Tracks))(Qty. 2)
6. Optional Polyphaser	14. 21V Power Supply Board
7. Ground Lug	15. Digital to Relay I/O Board
8. 1" NPT Conduit Hub	16. Rechargeable, Sealed Lead-Acid Battery
	(Secured by Battery Mounting Bracket)

Figure 2-1A - 4-Slot ControlWave EFM
(Shown with MDS - Transnet Radio & D-Type Local Port)

**Figure 2-1B - 8-Slot ControlWave EFM
(Shown with MDS - Transnet Radio & Circular Local Port)**

1. Fabrication Panel
2. ControlWave MICRO EFM 8-Slot Base Assembly
   (from Left to Right - SCM, CPU & 6 I/O Modules)
3. .5" Liquid Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug (Behind Item #8)
8. 1" NPT Conduit Hub

9. Local Comm. Port Connector
10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket
    (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board

Each **Control**Wave **EFM** Base Assembly (4/8-Slot) is housed in an open-faced Gold Irridite coated Aluminum Chassis assembly. Keyed cutouts in rear wall of the **Control**Wave **EFM** Base Assembly are provided for Wall or Panel mounting arrangements. The **Control**Wave **EFM** Base Assembly is mounted to the Fabricated Panel on the inner rear wall of the Hoffman Enclosure and is comprised of the following components:

- Built-in Card Guides accommodate installation/removal and vertical mounting of all Modules
- Built-in Chassis Ground Lug (on bottom of unit)
- Backplane PCB provides seating and electrical interface for all Modules
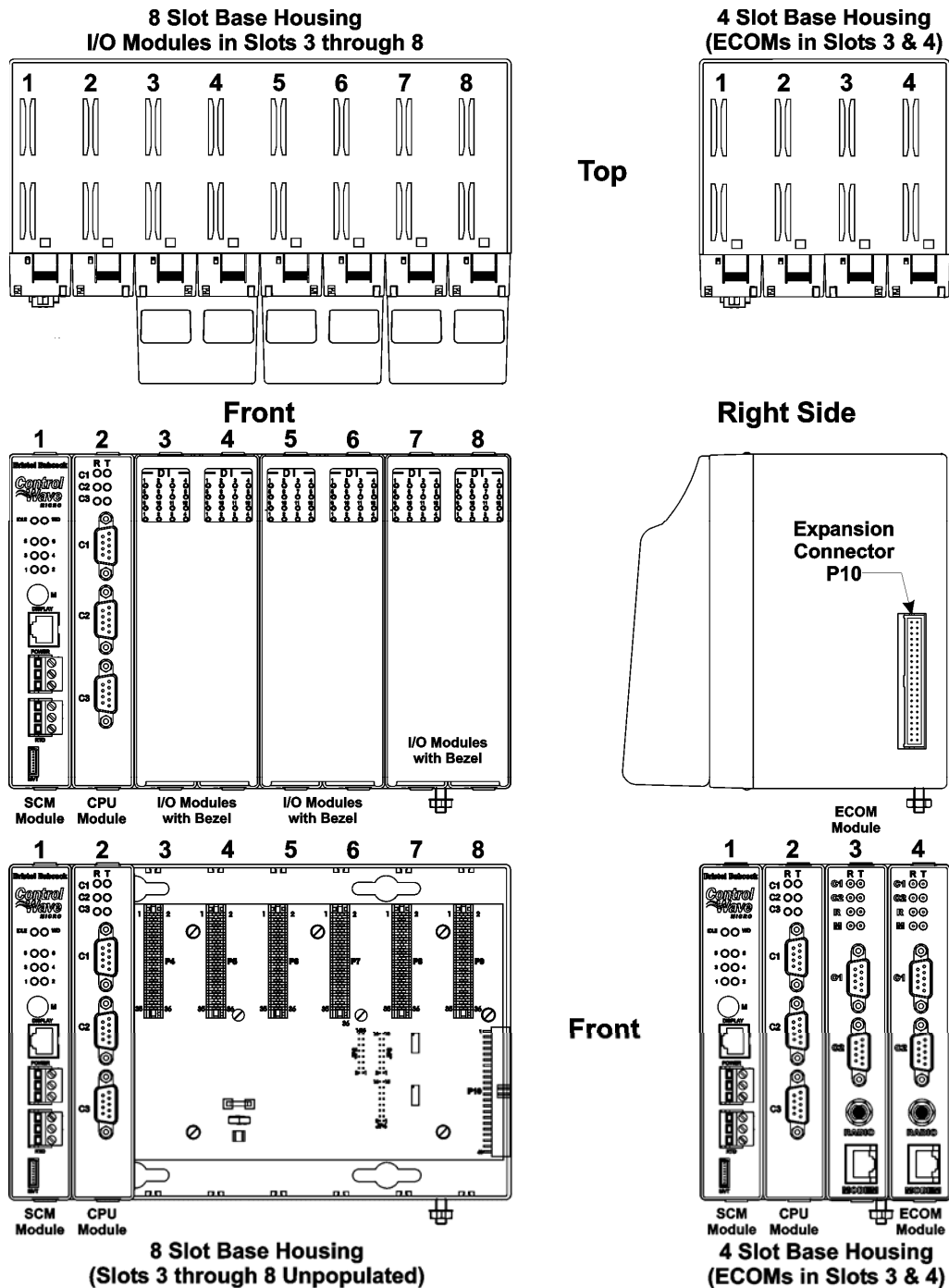
Figure 2-2 – 8/4-Slot Control Wave **EFM Base Assemblies - (The 4-Slot Chassis is shown with ECOMs in Slots 3 & 4)**

ControlWave **EFM** Modules that comprise the system are housed in a base assembly consisting of an open faced Gold Irridite coated Aluminum Chassis equipped with either a 4-Slot or 8-Slot Backplane. Dimensional drawings of the Base Assemblies are provided at the end of Chapter 4.

2.2 SITE LOCATION CONSIDERATIONS

Check all clearances when choosing an installation site. Make sure that the **Control**Wave **EFM** Instrument Front Cover (hinged on the left side) can be opened for wiring and service. Make sure that the LCD/Keypad is visible and accessible to the on-site operator. There should also be clearance for the optional Solar Panel (if required). The enclosed unit measures 14.55" in height by 13" in width by 6.875" in depth. The Multivariable Transducer adds 2.8" to the height of the unit.

Information on mounting the **Control**Wave **EFM** assembly at an installation site is provided in Section 2.3.1 <u>Mounting the **Control**Wave **EFM** Enclosure</u>.

2.2.1 Temperature & Humidity Limits

ControlWave **EFM** electronic flow computers have been designed to operate over a -40°F to +158°F (-40°C to +70°C) temperature range (with storage at up to +185°F (+85°C)) and a 0% to 95% Relative Humidity range. Make sure that the ambient temperature and humidity at the measuring site remains within these limits. Operation beyond these ranges could cause output errors and erratic performance. Prolonged operation under extreme conditions could also result in failure of the unit.

2.2.2 Vibration Limits

Check the mounted enclosure, panel or equipment rack for mechanical vibrations. Make sure that the **Control**Wave **EFM** is not exposed to a level of vibration that ex-ceeds those given in the specifications. **Control**Wave **EFM** vibration limits are 1g for 10 - 150 Hz & .5g for 150 - 2000 Hz.

2.3 **Control**Wave **EFM** INSTALLATION/CONIGURATION

ControlWave **EFM** electronic flow computers are shipped from the factory with all components (wired and mounted) except for the unit's Solar Panel and Battery (if provided); these items are shipped separately.

Overview of Configuration

An overview of the seven main configuration steps are provided herein.

Step 1. Hardware Configuration

This involves unpacking the **Control**Wave **EFM** hardware, mounting the enclosure, wiring I/O terminations, connecting any permanent communication cables, making proper ground connections, connecting a communication cable to a PC workstation and setting switches. To install and configure the **Control**Wave **EFM**, follow Hard-ware configuration steps 1 through 11 below:

1. Remove the unit from its carton and install it at the assigned work site (see Section 2.3.1). Dimensions are provided in Section 4.6 of this manual.
2. Remove the SCM Module and after configuring its jumpers, install it into **Control**Wave **EFM** Base Assembly, chassis slot 1, i.e., the first slot from the left end of the Base Assembly Chassis (see Section 2.3.2).
3. Remove the CPU Module. Make sure that the Lithium Backup Battery has been enabled, i.e., Backup Battery Board Jumper JP1 should be installed (on its jumper posts). After configuring the CPU Module's DIP-Switches (see Section 2.3.3) install it into **Control**Wave **EFM** Base Assembly, chassis slot 2, i.e., the second slot from the left end of the Base Assembly Chassis.
4. Configure/Connect appropriate communication port(s) (see Section 2.3.3.2). Connect COMM. Port 1 or 2 of the **Control**Wave **EFM** (depending on CPU Switch SW1 settings - see Section 2.3.3.1) to a Communication Port of a PC (typically PC COMM. Port 1). *Note: Also see Section 2.4.4.*
5. Install I/O wiring to each I/O Module (see Section 2.3.4). Install a communications cable to a Model 3808 Transmitter if required (see Section 2.3.8).
6. Install a ground wire between the Enclosure's Ground Lug and a known good Earth Ground (see Section 2.3.9.5).
7. Install the Bezel so that the I/O Modules are covered (see Section 2.3.11).
8. If required, install the RTD Probe (see Section 2.3.5).
9. Install the Rechargeable Lead Acid Battery and Solar Panel (if provided) (see Sections (2.3.9.3 & 2.3.9.4).
10. Connect DC Power wiring to the **Control**Wave **EFM** SCM (see Sections 2.3.9.1 & 2.3.9.2).
11. Apply power to the **Control**Wave **EFM.** Now continue with Steps 2 through 7 below (and Section 2.4.1) and the **Control**Wave **EFM** will be ready for on line operation.

Step 2. Software Installation on the PC Workstation

ControlWave **Designer** software will have to be installed on the PC if the **Control**Wave **EFM** is to be utilized in an application other than that supported by the standard load. This is accomplished by installing the **Control**Wave **Designer Package** from the Open BSI CD ROM.

You must install the **Open BSI Network Edition**. For information on minimum system requirements and more details of the installation, see the installation procedure in Chapter 2 of the *Open BSI Utilities Manual* (document # D5081).

If you have an older version of ControlWave Designer already installed:

Beginning with **Control**Wave Designer Version 3.3, the copy protection key (dongle) is NOT required. Prior to installing **Control**Wave Designer 3.3 or newer, you MUST remove the hardware dongle from the parallel port of your PC workstation. Otherwise, when you subsequently start **Control**Wave Designer, it will operate only in 'DEMO' mode, and will limit the available system resources.

IMPORTANT:
When you start ControlWave Designer, you will be reminded to register the software. Unregistered software can only be used for a maximum of 30 days. For more information on the registration process, see Chapter 2 of the Open BSI Utilities Manual (document # D5081).

Step 3. Establish Communications using either LocalView or NetView, and Run the Flash Configuration Utility

Communications must be established with the **Control**Wave **EFM** using either LocalView or NetView.

The **Control**Wave **EFM** ships from the factory with a default Flash configuration. Most users will need to edit this configuration to set the BSAP local address (IP address if using PPP), user accounts, and port parameters. This can be done in one of two ways:

- Either open the supplied Flash Configuration Profile (FCP) file and modify it, directly in the Flash Configuration Utility, or in a text editor,

- Or retrieve existing Flash Parameters directly from the unit, and edit them in the Flash Configuration Utility.

Detailed information on the Flash Configuration Utility, and LocalView is included in Chapter 5 of the *Open BSI Utilities Manual* (document # D5081). NetView is described in Chapter 6 of that same manual.

Step 4. Modification of the Application-Specific Control Strategy (OPTIONAL)

ControlWave **EFM** electronic flow meters are shipped with the EFM program already loaded. However, you can create your own application-specific control strategy using **Control**Wave Designer. This involves opening a new project using the 'CWMicro' template, defining I/O points using the I/O Configurator, and creating a program using one or more of the five supported IEC 61131 languages (FBD, ST, SFC, LD, or IL). Some of these languages are text based, others are graphical diagrams. The choice is up to you, depending upon your particular application.

The ***Control****Wave MICRO Quick Setup Guide* (document # D5124) includes a simple LD example. Additional examples are included in the manual, *Getting Started with **Control**Wave Designer* (document # D5085). More detailed information about **Control**Wave Designer and IEC 61131 is included in the ***Control****Wave Designer Reference Manual* (document # D5088).

The ACCOL3 Firmware Library, which is automatically accessible through the template referenced above, includes a series of function blocks which perform a variety of process control and communication functions. These can be included within your program to perform various duties including PID control, alarming, calculations, etc. Detailed information about each function block is included in the **Control**Wave Designer on-line help files.

On the variables declaration page(s) in **Control**Wave Designer, you will need to mark any variable you want to make accessible to external programs, such as Open BSI's DataView utility, as **"PDD"**. Similarly, any variables which should be collected into a database, or exported using the OLE for Process Control (OPC) Server must be marked as **"OPC."** Variables marked as OPC can be built into a text file by the **OpenBSI Signal Extractor.** The text file can then be used in the creation of a database for human machine interface (HMI) software such as OpenEnterprise or Iconics' Genesis. These HMI software packages require that the **"Datatype conversion enable"** option be selected when generating the file using Signal Extractor. Information about the OpenBSI Signal Extractor is included in Chapter 12 of the *Open BSI Utilities Manual* (document # D5081).

Once the program has been created, it is assigned to an executable task. The entire project is then saved and compiled.

NOTE: From this point on, the order of steps may be varied, somewhat, depending upon the requirements of the user's application.

NOTE: If you modify the standard EFM program, you may need to modify the standard web pages associated with it. (See Step 5, below).

Step 5. Use Standard Web Pages Provided to Select Options in the Standard Control Strategy

The **Control**Wave **EFM** has a standard set of web pages for configuration purposes (stored on a PC) that lets you enter parameters, and configuration options for the standard EFC program (see Step 4, above). If you modify the standard EFM program, you may need to modify the standard web pages. If you create your own application program (instead of using the standard one), you may create your own web pages using Bristol ActiveX controls discussed in the *Web_BSI Manual* (document # D5087).

You can use whichever HTML creation package you want to create the pages, however, all **Control**Wave **EFM** related web pages (whether standard or user-created) must be viewed within Microsoft® Internet Explorer. Web pages are stored on a PC workstation.

Step 6. Create an Open BSI Network Containing the ControlWave EFM, or ADD the ControlWave EFM to an Existing Open BSI Network

In order for the **Control**Wave **EFM** unit to function as part of a Bristol Babcock network, it is necessary to include it in the Bristol Babcock network.

If no Bristol network exists:
You need to run Open BSI's NetView software on the PC workstation in order to define a Bristol network. A series of software wizards are used to define a Network Host PC, a network, and the RTUs (controllers) assigned to the network. Finally, communication lines must be specified which handle the address assigned to the **Control-**Wave **EFM**. Chapters 3 and 4 of the *Open BSI Utilities Manual* (document # D5081) include 'quick start' examples for performing these steps. More detailed information is included in the NetView chapter (Chapter 6) of D5081.

If a Bristol network already exists:
You will need to add the **Control**Wave **EFM** to the existing network using Net-View's RTU Wizard. Chapter 6 of the *Open BSI Utilities Manual* (document # D5081) includes different sub-sections depending upon whether you are adding the unit to a BSAP network, or an IP network.

Step 7. If applicable, download new or modified control strategy (OPTIONAL)

If you modified the standard EFM program, or substituted your own program, compile and download the new or modified program into the unit, using either ControlWave Designer, or the Open BSI 1131 Downloader. In this case, you download the control strategy into the BOOT project area of FLASH memory; this ensures that if the **Control**Wave **EFM** is reset, or if there has been a failure of the backup battery, the control strategy can be restarted from the beginning, i.e. from the BOOT project in FLASH memory. To download the project, see Section 2.4.1.

2.3.1 Mounting the ControlWave EFM Enclosure

When mounting one of these units, it is to be positioned in accordance with the following restrictions:

- The unit is to be positioned vertically with the Multivariable Transducer (MVT) at its base and is to be mounted to a wall or a vertical 2" pipe (clamed at the rear of the unit via two clamps and four bolts). If used, the 2" pipe is to be anchored in cement (deep enough to conform to local building codes associated with frost considerations). The basic unit measures 14.55" in height by 13" in width by 6.875" in depth. A Multivariable Transducer adds 2.8" to the unit's height. See Figures 2-3 and 2-4.

(1) 1" NPT Conduit Hub
(3) RTD Cable Assembly or Sealing Plug
(5) 5" Liquid Tight Conduit Fitting or Plug
(7) Solderless Ground Lug
(8) Multivariable Transducer

(2) Local Port D-Type Jack
   Male D-Type Jack or
   Circular Female Jack
(4) Battery Ventilation Assembly
(6) Ant. Cable Fitting, Polyphaser, or Plug
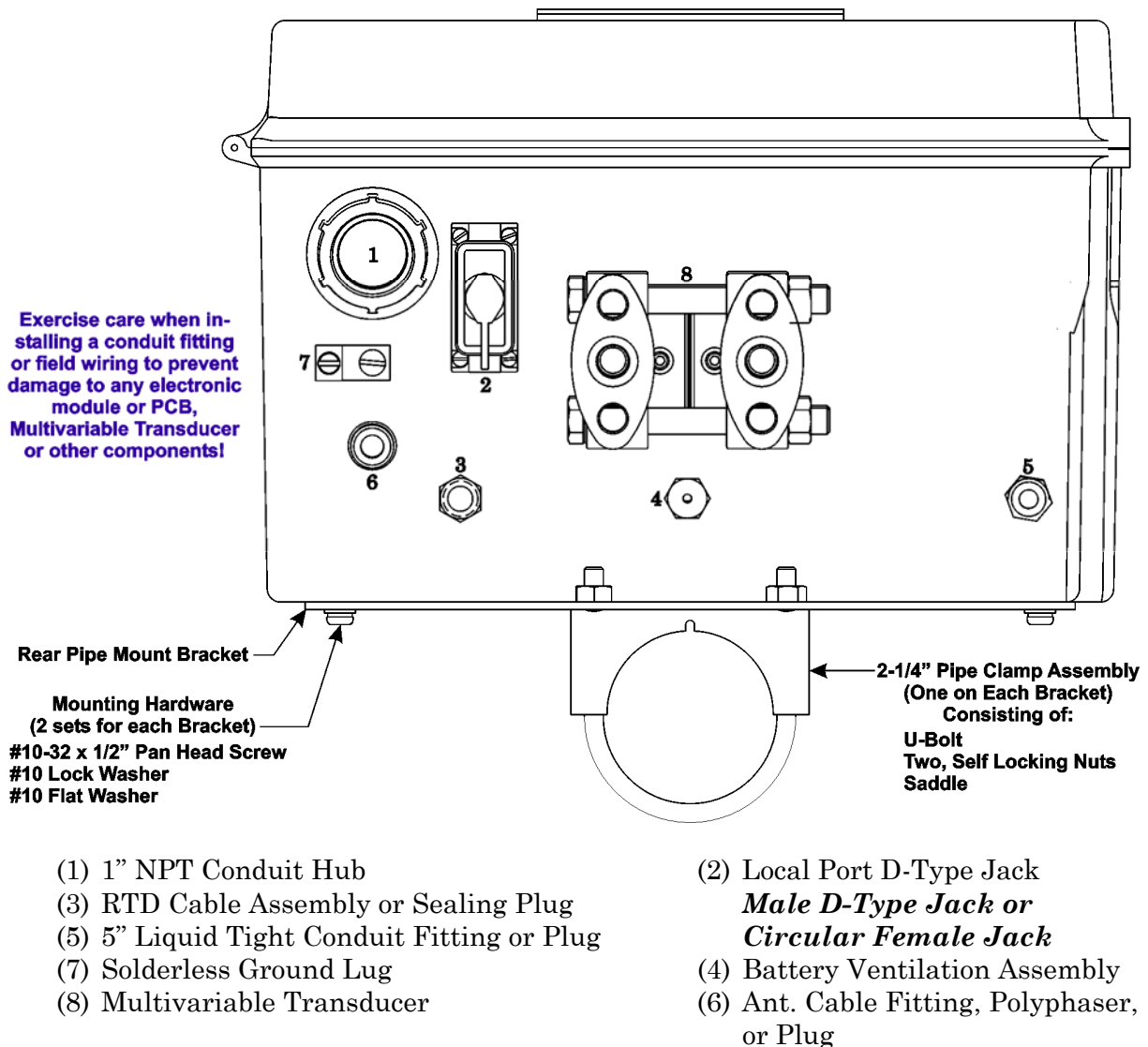
Figure 2-3 - ControlWave EFM Bottom View

- The Multivariable Transducer (MVT) is bolted to a process manifold which in-turn is connected to the main (meter run) directly or via two pipes (see Figures 2-5 - 2-7).
- The unit must be positioned so that the front of the assembly is visible and the unit is accessible for service, i.e., installing an option or replacement of the Lithium Battery, or installation/removal of any **ControlWave EFM** Module.
- Make certain that the LCD Display/Keypad is accessible and visible to the on-site operator.

- There should be clearance for the optional Solar Panel (if required) (the Solar Panel may be mounted to the same 2" pipe that secures the unit.
- Power wiring should not be installed until the unit has been mounted and grounded at a designated work site.
- I/O wiring, external power wiring, RTD cabling, local comm. port, antenna cable, and network (RS-232 and RS-485) comm. port cabling enter the bottom of the unit though conduit or special function fittings.

Pipe (Muffler) Clamp Ass'y. (Qty. 2)

Rear Pipe/Pole Mounting Bracket (Qty. 2)

Mounting Hardware
(2 sets for each Bracket)
#10-32 x 1/2" Pan Head Screw
#10 Lock Washer
#10 Flat Washer

2 Inch Pipe
or Pole

Mounting Hardware
(2 sets for each Bracket)
#10-32 x 1/2" Pan Head Screw
#10 Lock Washer
#10 Flat Washer
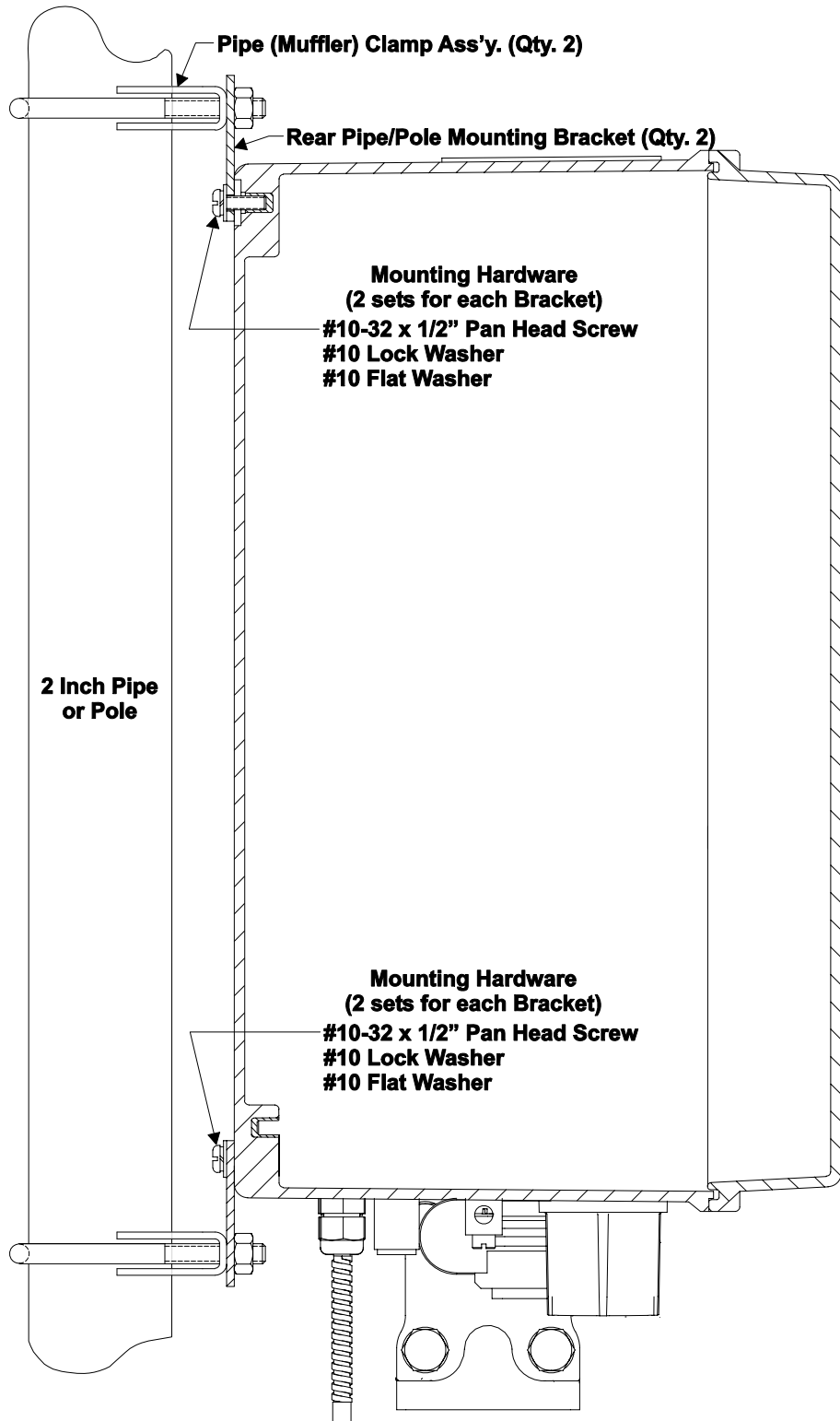
Figure 2-4 - Side View of ControlWave EFM Mounted to a 2" Pipe

2.3.1.1 Connection to the Multivariable Transducer (MVT)

One Multivariable Transducer (MVT) is provided with each **Control**Wave **EFM** and is secured to the bottom of the enclosure. Figure 2-5 details MVT process flange and optional manifold block connector mounting dimensions.

The MVT provides connection ports on the process flange as the standard arrangement. Optional manifold blocks may also be specified. Both arrangements are described as follows:

Standard Process Flange: Two process flanges containing the connection ports are assembled to the transmitter. Port designations (L and H) are stamped on the body of the flanges. Ports accept 1/4-18 NPT pipe connections on 2-1/8 in. centers for connection to orifice taps or a standard three-valve manifold. These process flange connections are illustrated at the top of Figure 2-5.

The two process flange assemblies are held in place by four bolts and nuts. When the bolts are removed, the flanges can be repositioned so that the connections can emanate from the front, rear or bottom of the transmitter. Care should be taken not to damage the sensor module assembly during this procedure. Once the flange has been positioned, the bolts should be tightened in an alternating sequence to about 20-30 foot-pounds of torque.
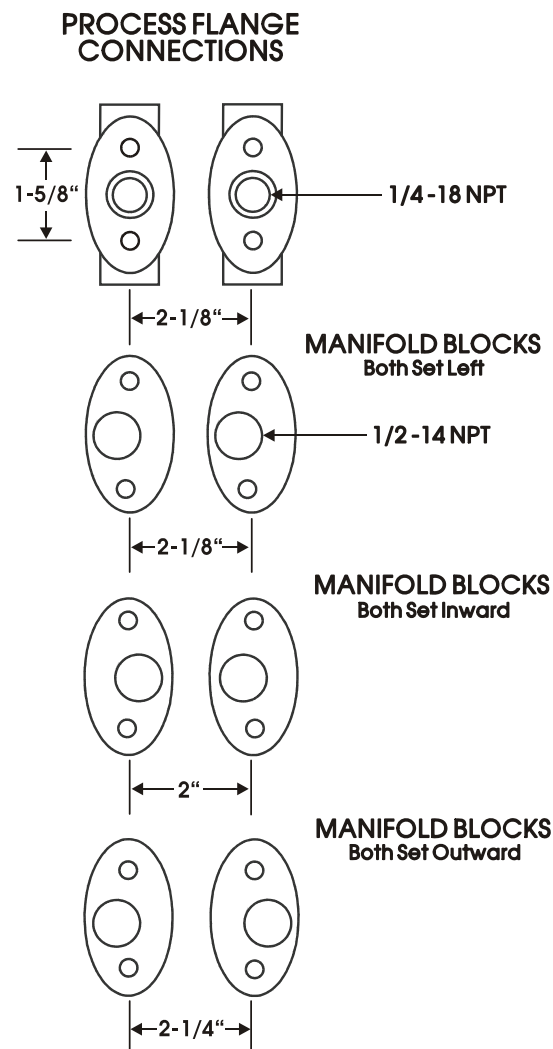
Figure 2-5 - Process Flange and Optional Manifold Block Connectors

Optional Process Manifold Blocks: Process manifold blocks may be installed on the transmitter to permit the use of connector assemblies having different connection centers. The manifold blocks, which are oval in appearance, mate with the transmitter's process flange. The blocks may be installed in several positions to achieve different connection centers as shown in Figure 2-5.

MVT Interface Cable. An interface, connected to the top of the MVT, is factory connected to Connector P2 near the bottom of the System Controller Module. This cable is keyed to simplify installation.

2.3.1.2 Process Pipeline Connection (Meter Runs without Cathodic Protection)

ControlWave **EFM**s may be mounted directly on the pipeline or remotely on a vertical stand-alone two-inch pipe or a wall. The Earth Ground Cable is to run between the **Control**Wave **EFM**'s Ground Lug and Earth Ground (Rod or Bed) even though the **Control**Wave **EFM**'s Multivariable Transducer (MVT) may be grounded to the pipeline. If any pressure transmitters or pulse transducers are remotely mounted, connect their chassis grounds to the pipeline or earth ground.
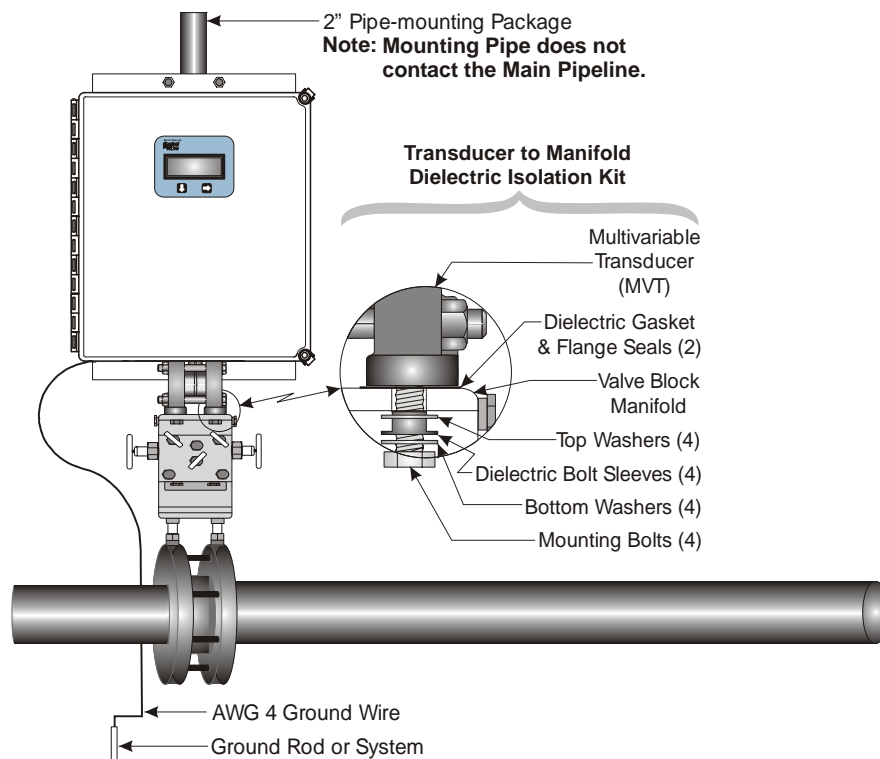
Figure 2-6 - Control Wave **EFM**
Direct Mount Installation with Cathodic Protection

Note: Direct Mount installation of a unit, without Cathodic protection, is similar to that of Figure 2-6 except it doesn't utilize the Transducer to Manifold Dielectric Isolation Kit.

2.3.1.3 Process Pipeline Connection (Meter Runs with Cathodic Protection)

Dielectric isolators are available from Bristol Babcock and are always recommended as an *added measure* in isolating the ControlWave EFM from the pipeline even though the enclosure does provide some galvanic isolation from the pipeline and should not be affected

by cathodic protection or other EMF on the pipeline. **Control**Wave **EFM**s may be mounted directly on the pipeline (see Figure 2-6) or remotely on a vertical stand-alone two-inch pipe (see Figure 2-7). It is recommended that isolation fitting always be used in remotely mounted meter systems. An isolation fittings or gasket should be installed between the following connections:

- all conductive tubing that runs between the pipeline and mounting valve manifold and/or the units Multivariable Transducer (MVT)
- all conductive connections or tubing runs between the **Control**Wave **EFM** electronic flow meter and a turbine meter, pulse transducer, or any other I/O device that is mounted on the pipeline
- any Temperature Transducer, Pressure Transmitter, etc. and their mount/interface to the pipeline.
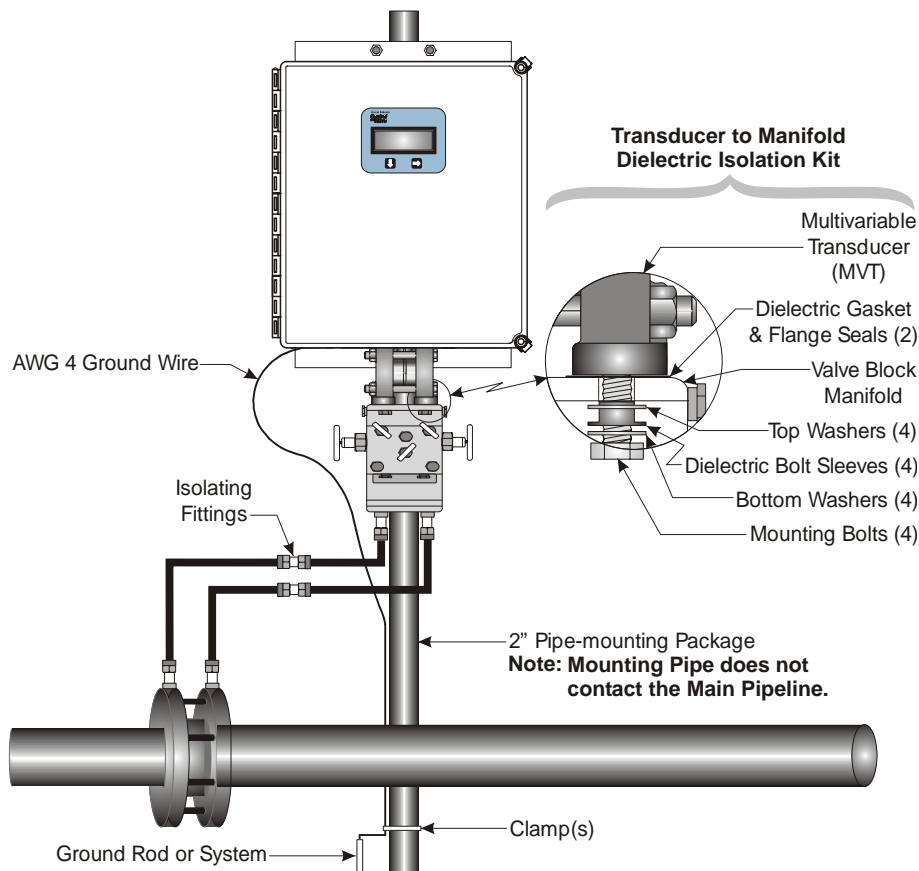
Figure 2-7 - ControlWave EFM Remote Installation
(with Cathodic Protection)

Note: Remote installation of a unit, without Cathodic protection, is similar to that of Figure 2-7 except it doesn't utilize the Transducer to Manifold Dielectric Isolation Kit.

Mount the **Control**Wave **EFM**'s enclosure on a stand-alone vertical 2-inch pipe or on a wall. The ground conductor connects between the **Control**Wave **EFM**'s Chassis Ground Lug and a known good earth ground. Connect the cases of Temperature Transducers, Pressure Transmitters, etc., to the known good earth ground. If the mounting 2-inch pipe (when used) is in continuity with the pipeline it will have to be electrically isolated from the **Control**Wave **EFM**. Use a strong heat-shrink material such as RAYCHEM WCSM 68/22 EU 3140. This black tubing will easily slip over the 2-inch pipe and then after uniform

heating (e.g., with a rose-bud torch) it electrically insulates and increases the strength of the pipe stand. See Bristol Specification Summary F1670SS-0a for information on PGI Direct Mount Systems and Manifolds.

2.3.2 System Controller Module (SCM) Configuration

System Controller Module' (SCM) configuration jumpers must be set to configure bulk power (+6Vdc or +12Vdc nominally) and to enable or disable the Power Good LED (see Figure 2-8). The SCM is installed in Backplane slot #1 (see Figure 2-2). Slot #1 is the first slot, counting left to right, and provides 44-pin female interface connector P1.
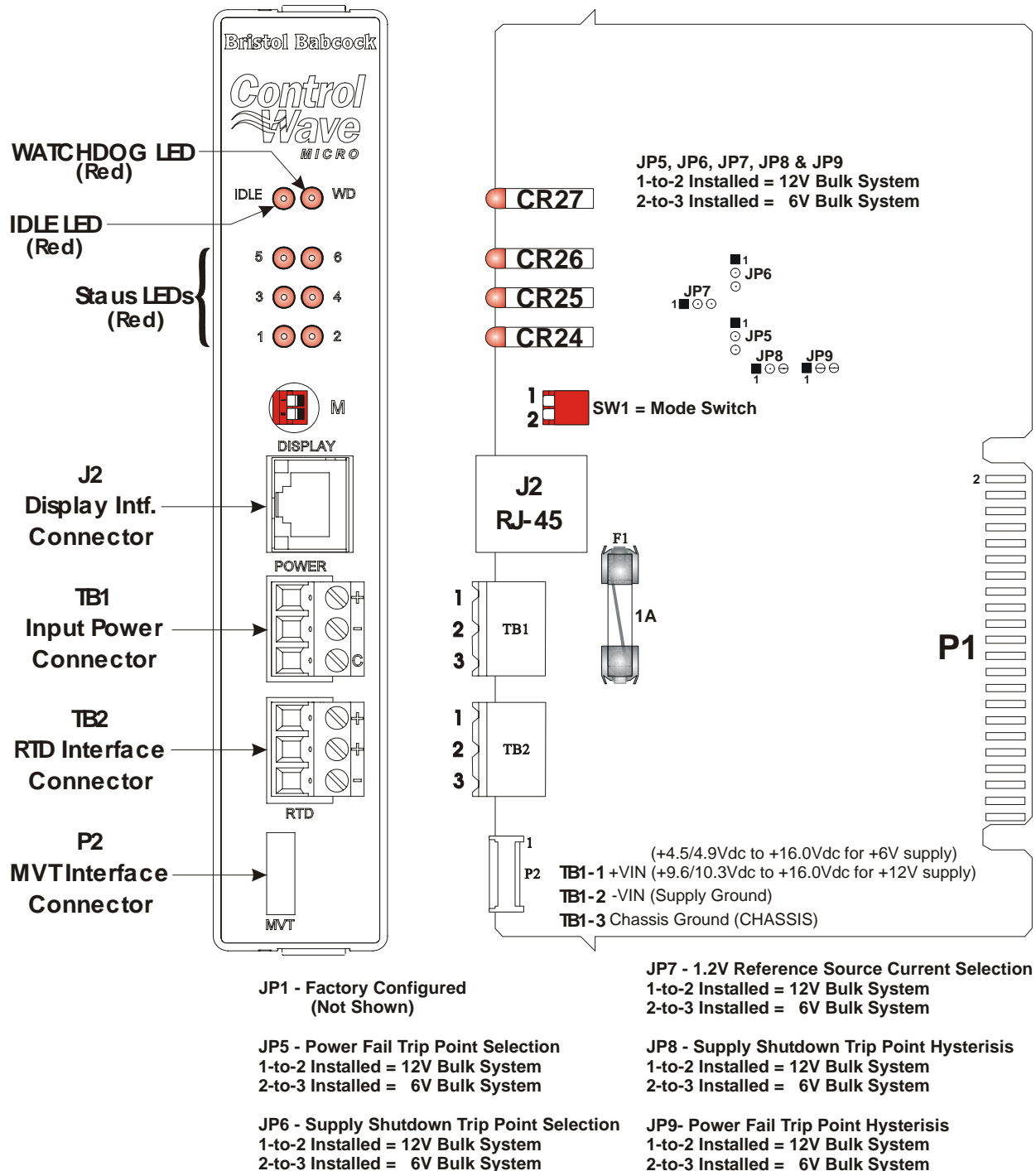
Figure 2-8 - System Controller Module Component Identification Diagram

For safety reasons and to prevent accidental damage to a user supplied external bulk DC Power Supply, it is recommended that pluggable Terminal Block connector TB1 be disconnected from the SCM until the entire unit has been wired, and hardware configured. Sections 2.3.9.1 & 2.3.9.2 provide details on DC Power Connector TB1 wiring.

Table 2-1 - System Controller Module Switch SW1 – User Configurations

Switch	Function	Setting - (ON = Factory Default)
SW1-1/2	Recovery/Local Mode	Both Open/Closed = Recovery Mode SW1-1 Open (right) & SW1-2 Closed (left) = Local Mode

Note: Only SCM Switch SW1 settings listed in this table have been tested.

2.3.3 CPU Module & ECOM Module Configuration

To configure the CPU Module, Jumpers must be set (see Figure 2-9), DIP-Switches must be set (see Section 2.3.3.1) and Communication Ports must be wired (see Sections 2.3.3.2 through 2.3.3.3). The CPU Module resides in Base Chassis Backplane Slot #2 (see Figure 2-2). Backplane Slot #2 provides 44-pin female interface connector P2 on the bottom and 36-pin female interface connector P3 on the top.

2.3.3.1 CPU Module Switch Configuration

ControlWave **EFM** CPU Module DIP-Switches must be set for the desired performance options. Tables 2-2, 2-3 and 2-6 provide an overview of switch settings.

SW2-1 set OFF will disable the system from entering a watchdog state when a crash or system hangup occurs. Setting SW2-1 OFF prevents the system from automatically restarting.

SW2-2 set OFF prevents changing the Soft Switches, other configurations and FLASH files, i.e., these items are locked. To change Soft Switch, configuration and FLASH files SW2-2 must be set to the ON position (see Section 2.4.4).

Table 2-2 - CPU Bd. Switch SW2 - User Configurations
Note: Except for SW2-4, ON = Factory Default

Switch	Function	Setting - (ON = Factory Default)
SW2-1	Watchdog Enable	ON = Watchdog circuit is enabled OFF = Watchdog circuit is disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump Enabled via Mode Switch (SW1) on SCM
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-7	N/A	
SW2-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

* = Boot PROM version 4.7 or higher and System PROM version 4.7 or higher

SW2-3 set OFF forces the use of Soft Switches as set per factory default (see Section 2.4.4). For use of user defined Soft Switches, SW2-3 must be set to the ON position. *Note: If both SW2-3 and SW2-8 are set OFF (closed), all communication ports will be set to 9600 bps operation (8-bits, no parity, 1 stop bit, BSAP Protocol).*

SW2-4 set OFF and used in conjunction with the SCM Mode switch will cause the **Control**Wave **EFM** to perform a Core Updump (see Section 3.6).

SW2-6 set ON will enable the user to perform a remote download of System Firmware (see Section 2.4.2.3).

SW2-5 set OFF forces the **Control**Wave **EFM** to reinitialize SRAM when the unit recovers from a low power or power outage condition. When set ON, the contents of SRAM will be retained and utilized when the system restarts. **Note: If the Battery is removed from the CPU Module (CPU removed) CPU should not be installed (and power applied) before one minute has passed unless SW2-5 on the CPU has been set OFF.**

SW2-8 set OFF prevents the 'Boot Project' from running and places the unit into diagnostic mode. SW2-8 must be set OFF to run the WINDIAG program resident on the local PC (**see Section 3.5**). When SW2-8 has been set ON, diagnostics is disabled. SW2-8 must be set to the ON position for normal system operation, i.e. for the Boot project to run. *Note: If both SW2-3 and SW2-8 are set OFF (closed), all communication ports will be set to 9600 bps operation (8-bits, no parity, 1 stop bit, BSAP Protocol).*

Table 2-6 in Section 2.3.3.3 provides CPU Switch SW3 (COM3) and ECOM Switch SW1 COM5/9 RS-485 communication port settings.
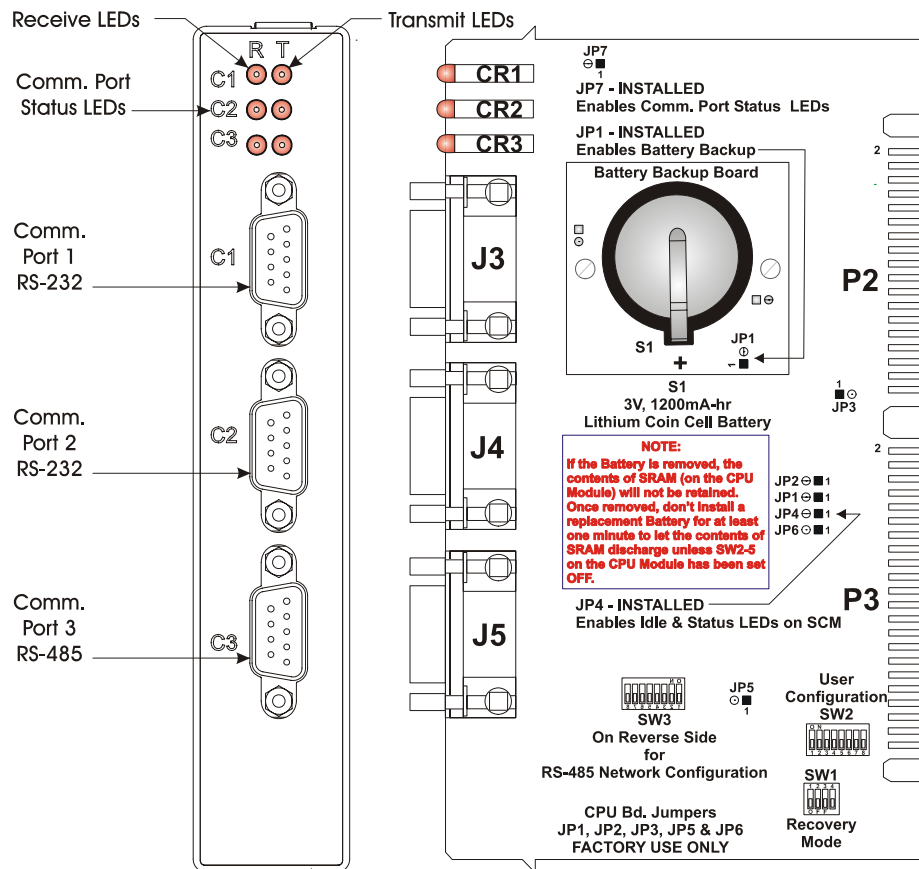
Figure 2-9 - CPU Module Component Identification Diagram

Table 2-3 - CPU Bd. Switch SW1 - Force Recovery Mode/Battery Enable

Switch	Function	Setting - (OFF = Factory Default)
SW1-3	Force Recovery Mode	ON = Force recovery mode (via CW Console) OFF = Recovery mode disabled

Note: SW1-1, SW1-2 and SW1-4 are not used.

2.3.3.2 Communication Ports

A **Control**Wave **EFM** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. A variety of communication schemes are available. One optional 56K Modem and one optional Spread Spectrum Modem can be piggy-back mounted on Expansion Communications Modules (or the Modem can be on one ECOM Module while the radio is on the other). In lieu of an internal radio (Spread Spectrum Modem), an external radio can be mounted on a radio mounting bracket within the enclosure.
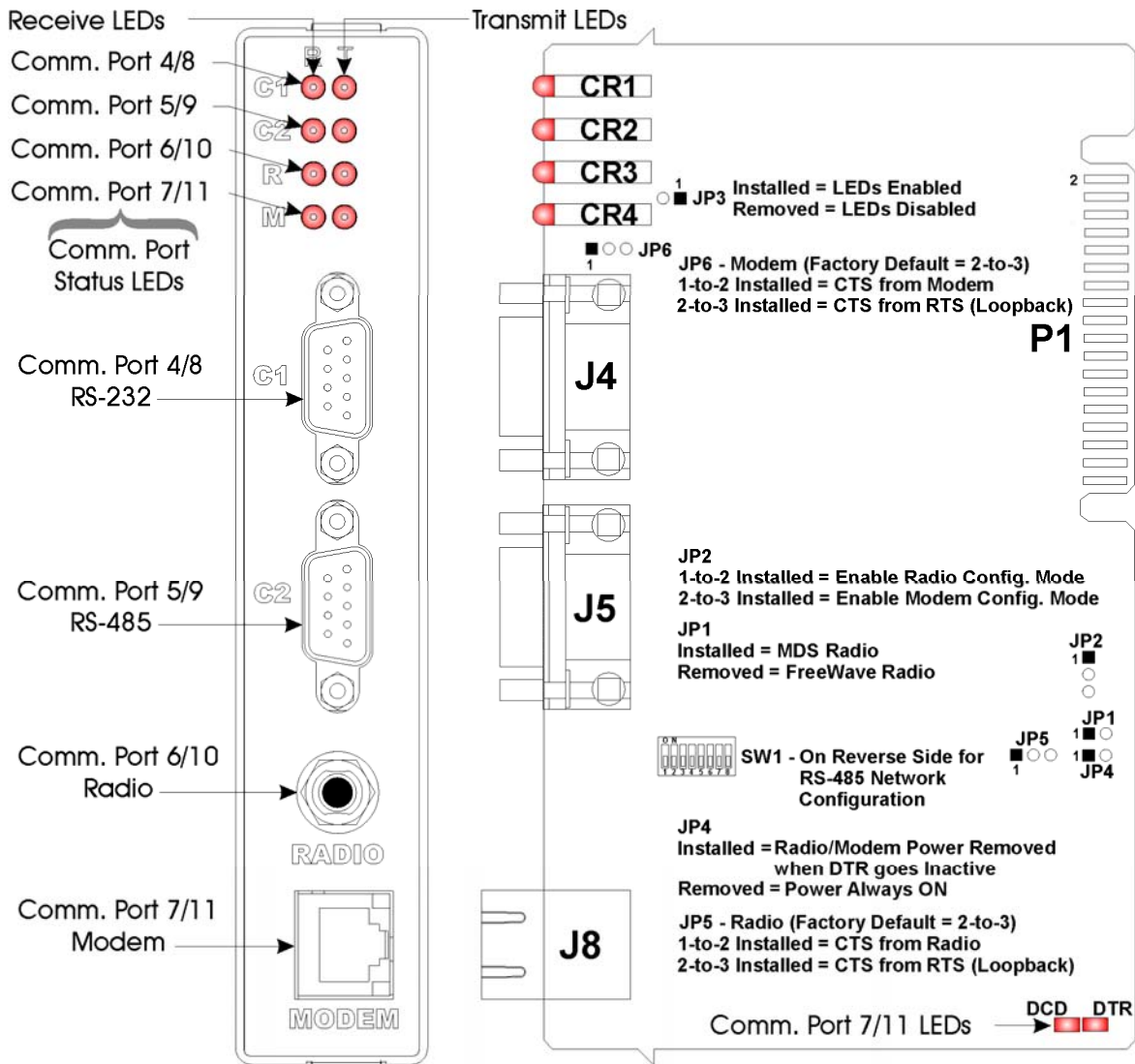
Figure 2-10 - ECOM Module Component Identification Diagram

Up to three communication ports are contained on the **Control**Wave **EFM** CPU Module and are designated as follows:

CPU Module:
COM1 - Port 1:   CPU Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232 - connected to Local Port
COM2 - Port 2:   CPU Bd. J4, PC/AT 9-Pin Male D-Sub - RS-232 - supports External Radio
COM3 - Port 3:   CPU Bd. J5, PC/AT 9-Pin Male D-Sub - RS-485 - Configured by SW3

The **Control**Wave **EFM** can support up to two optional Expansion Communications Modules, which can reside in slots 3 and 4 (ONLY), in lieu of I/O Modules. Each Expansion Communications Module contains two serial communications ports (one RS-232 and one RS-485), and may contain an optional built-in spread spectrum modem (radio) and/or an optional built-in 56KB PL/PSTN modem that are designated as follows:

Expansion Communications Module:
COM4, COM5, COM6 & COM7 on first ECOM Bd., assigned to Base Chassis Slot #3
COM8, COM9, COM10 and COM11 on second ECOM Bd., assigned to Base Chassis Slot #4
COM4/8 -   Port 1: ECOM Bd. J1, PC/AT 9-Pin Male D-Sub - Both RS-232
COM5/9 -   Port 2: ECOM Bd. J2, PC/AT 9-Pin Male D-Sub - Both RS-485 - Configured by SW1 on ECOM Board
COM6/10 - Port 3: ECOM Bd. Piggy-back Radio Module (FreeWave or MDS TransNet Spread Spectrum Modem) Antenna connector provided
COM7/11 - Port 4: ECOM Bd. Piggy-back Modem Module (MultiTech 56KB PL/PSTN Modem) RJ-11 connector provided

Note: These RS-485 Ports are optionally available with 500Vdc isolation.

COM1 is also available as the Local Port. This accomplished by either a 9-pin D-Type male connector or a circular 3-pin female connector. The Local Port is situated on the bottom of the instrument.

Communication Ports COM1, COM2, COM3, COM4, COM5, COM8 and COM9 support serial asynchronous operation. Communication Ports COM1, COM2, COM4 and COM5 support RS-232 while COM3, COM5 and COM9 support RS-485 operation. Com-munication Ports COM4/8, COM5/9, COM6/10 and COM7/11 reside on optional Expansion Communications Modules (ECOM1/2). ECOM1 must reside in Base Chassis Backplane Slot #3 while ECOM2 must reside in Base Chassis Backplane Slot #4. ECOM Modules have one RS-232 Port and one RS-485 Port. Additionally, an ECOM Module may optionally contain a 56Kbaud PSTN Modem and/or a Spread Spectrum Modem (Radio). Any non-Ethernet communication ports can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software.

The connections for the 9-pin, RS-232/485 interface are shown in Figure 2-11, while the corresponding pin labels are provided in Table 2-4A.

2.3.3.3 RS-232 & RS-485 Interfaces

ControlWave **EFM** RS-232 & RS-485 communications connectors are summarized below:

CPU Module:
COM1 - Port 1:   CPU Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232
COM2 - Port 2:   CPU Bd. J4, PC/AT 9-Pin Male D-Sub - RS-232
COM3 - Port 3:   CPU Bd. J5, PC/AT 9-Pin Male D-Sub - RS-485

<u>**Expansion Communications Module 1:**</u> **Resides in Base Chassis Backplane Slot #3**
COM4 - Port 1:   ECOM Bd. J1, PC/AT 9-Pin Male D-Sub - RS-232
COM5 - Port 2:   ECOM Bd. J2, PC/AT 9-Pin Male D-Sub - RS-485
<u>**Expansion Communications Module 2:**</u> **Resides in Base Chassis Backplane Slot #4**
COM8 - Port 1:   ECOM Bd. J1, PC/AT 9-Pin Male D-Sub - RS-232
COM9 - Port 2:   ECOM Bd. J2, PC/AT 9-Pin Male D-Sub - RS-485

RS-232 Ports
An RS-232 interface supports Point to Point, half-duplex and full-duplex communications (20 feet maximum, using data quality cable). Half-duplex communications supported by the **Control**Wave **EFM** utilize MODBUS or BSAP protocol, while full-duplex is supported by the Point to Point (PPP) protocol. **Control**Wave **EFM** RS-232 ports utilize the "null modem" cable (Figure 2-12A) to interconnect with other devices such as a PC, printer, another **Control**Wave **EFM** or **Control**Wave series unit (other than **CW_10/30/35**) when the **Control**Wave **EFM** is communicating using the full-duplex PPP protocol. The half-duplex cable shown in Figure 2-12A is utilized when the **Control**Wave **EFM** is connected to another **Control**Wave **EFM** or **Control**Wave series unit (other than **CW_10/30/35**). If communicating with a Bristol series 3305, 3310, 3330, 3335 or **CW_10/30/35** RTU/DPC, one of the cables shown in Figure 2-12B must be used. Refer to Figure 2-12C to connect a **Control**Wave **EFM** serial RS-232 port to either an external modem or external radio. When interfacing to Port COM3 of a **Control**Wave unit, or to COM5 or COM6 of a **Control**Wave**EXP**, the cable of Figure 2-12D must be used along with the one of Figure 2-12A or 2-12B.

Illustrations of the Local Communication Port cable connections (Typically Comm. Port 1) are provided in Figures 2-13A and 2-13B. An illustration of the CPU Module's male 9-pin D-type connectors is provided in Figure 2-11. Table 2-4A provides the connector pin assignments for ports COM1, COM2, COM3 and expansion communications ports COM4/5 & COM8/9. Table 2-4B provides pin assignments associated with the circular Local Port.

Note: The following facts regarding **Control**Wave **EFM** RS-232 serial communication ports should be observed when constructing communications cables:

- DCD must be high to transmit (except when dialing a modem)
- Each RS-232 transceiver has one active receiver while in powerdown mode (disabled); the DCD signal is connected to the active receiver.
- CTS must be high to transmit.
- When port is set for full-duplex operation - RTS is always ON.
- DTR is always high (when port is active); DTR enables RS-232 Transceivers.
- When port is set for half-duplex operation - CTS must go low after RTS goes low.
- All RS-232 Ports support RTS, DTR, CTS, DCD and DSR control signals.
- All RS-232 Port I/O signals are protected by LCDA12C surge protectors to ±4KV ESD.

Looking Into Bd. Receptacle

Figure 2-11 - Male DB9 9-Pin Connector Associated with COM1/2/3/4/5/8/9

Fig. A — Comm Intf. Cables for PC & CW*

CW* or PC
9-Pin Female "D" Connector — P1

5 = GND → To P2 Pin-5
4 = DTR → To P2 Pin-6
8 = CTS
3 = TXD → To P2 Pin-2
7 = RTS → To P2 Pin-1
2 = RXD → To P2 Pin-3
6 = DSR → To P2 Pin-4
1 = DCD → To P2 Pin-7

or vice versa

CW EFM
9-Pin Female "D" Connector — P2

1 = DCD
6 = DSR
2 = RXD
7 = RTS
3 = TXD
8 = CTS
4 = DTR
5 = GND

Full-duplex (Null Modem) Cable (PPP Protocol) (Internal Radio/Modem Configuration) Bristol P/N 392843-01-3

CW*
9-Pin Female "D" Connector — P1

5 = GND → To P2 Pin-5
4 = DTR → To P2 Pin-1
8 = CTS
3 = TXD → To P2 Pin-2
7 = RTS
2 = RXD → To P2 Pin-3
1 = DCD → To P2 Pin-4

or vice versa

CW EFM
9-Pin Female "D" Connector — P2

1 = DCD
2 = RXD
7 = RTS
3 = TXD
8 = CTS
4 = DTR
5 = GND

Half-duplex Cable (CW*)

Fig. A
Comm Intf. Cables for PC & CW* where CW* = any ControlWave series unit (other than CW_10/30/35)
(Looking into Wire Terminal Side of Cable Connectors)

Fig. B — Comm. Intf. Cables for 3305/3310/3330/3335

3305/3310/3330/3335/CW_10/30/35
9-Pin Male "D" Connector — P1

1 = DTR → To P2 Pin-1
6 = CTS
2 = TXD → To P2 Pin-2
7 = DCD → To P2 Pin-4
4 = RXD → To P2 Pin-3
9 = GND → To P2 Pin-5
5 = RTS

CW EFM
9-Pin Female "D" Connector — P2

1 = DCD
2 = RXD
3 = TXD
4 = DTR
5 = GND
7 = RTS
8 = CTS

Full-duplex Cable (PPP Protocol)

3305/3310/3330/3335/CW_10/30/35
9-Pin Male "D" Connector — P1

1 = DTR
6 = CTS
7 = DCD
2 = TXD → To P2 Pin-2
4 = RXD → To P2 Pin-3
9 = GND → To P2 Pin-5
5 = RTS

CW EFM
9-Pin Female "D" Connector — P2

2 = RXD
3 = TXD
5 = GND
1 = DCD
7 = RTS
8 = CTS
4 = DTR

Half-duplex Cable

Fig. B
Comm. Intf. Cables for 3305/3310/3330/3335
(Looking into Wire Terminal Side of Cable Connectors)

Fig. C — Comm. Intf. Cables for External Modem & Radio

To/From MODEM
To DCD — 1 = DCD
To RXD — 2 = RXD
To TXD — 3 = TXD
To DTR — 4 = DTR
To GND — 5 = GND
7 = RTS
8 = CTS

PSTN Modem Intf. Cable

CW EFM
9-Pin Female "D" Connectors

To/From RADIO
To RXD — 2 = RXD
To RTS — 7 = RTS
To TXD — 3 = TXD
To CTS — 8 = CTS
To GND — 5 = GND
1 = DCD
4 = DTR

PL Modem or Radio Intf. Cable

Fig. C
Comm. Intf. Cables for External Modem & Radio
(Looking into Wire Terminal Side of Cable Connectors)

Fig. D — RJ45 to DB9 Cable Ass'y. Bristol P/N 392844-01-0

CW (COM3) or CWEXP (COM3/5/6)
8-Pin RJ45 Plug — P1
(Looking into Connector Intf. Side of P1)

Pin 1 (Wht/Grn Stripe) to Pin 1 = DCD
Pin 2 (Wht/Blu Stripe) to Pin 6 = DSR/RX+
Pin 3 (Blu/Wht Stripe) to Pin 2 = RXD/RX-
Pin 4 (Grn/Wht Stripe) to Pin 7 = RTS
Pin 5 (Wht/Org Stripe) to Pin 3 = TXD/TX-
Pin 6 (Wht/Brn Stripe) to Pin 8 = CTS
Pin 7 (Orn/Wht Stripe) to Pin 4 = DTR/TX+
Pin 8 (Brn/Wht Stripe) to Pin 5 = GND

P2 — 9-Pin Male "D" Connector
(Looking into Wire Terminal Side of P2)

Figure 2-12 - Communication Port RS-232 Cable Wiring Diagram

Table 2-4A - RS-232 Ports (1/2/4/8) and RS-485 Ports (3/5/9) Pin Assignments

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	RXD	Receive Data Input	RXD-	Receive Data - Input
3	TXD	Transmit Data Output	TXD-	Transmit Data - Output
4	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Output
5	GND	Signal/Power Ground	GND/ISOGND*	Ground/Isolated Ground
6	DSR	Data Set Ready Input	RXD+	Receive Data + Input
7	RTS	Request To Send Output		N/A
8	CTS	Clear To Send Input		N/A

* ISOGND on Isolated RS-485 Ports Only! Note: Pin-9 not used

Table 2-4B - RS-232 Port (COM1) Connector Pin Assignments
(COM1 Connectors, i.e., Circular Local Port & D-Type 'C1' on CPU)

COM1 Pin #	Signal RS-232	Description: RS-232 Signals	Wire Color	Local Port RS-232 Pin #
1	DCD	Data Carrier Detect Input	Green	1
2	RXD	Receive Data Input	White	7
3	TXD	Transmit Data Output	Red	2
4	DTR	Data Terminal Ready Output	Brown	4
5	GND	Power Ground	Black	6
6	DSR	Data Set Ready Input		
7*	RTS	Request To Send Output		
8*	CTS	Clear To Send Input		

* = RTS connected to CTS
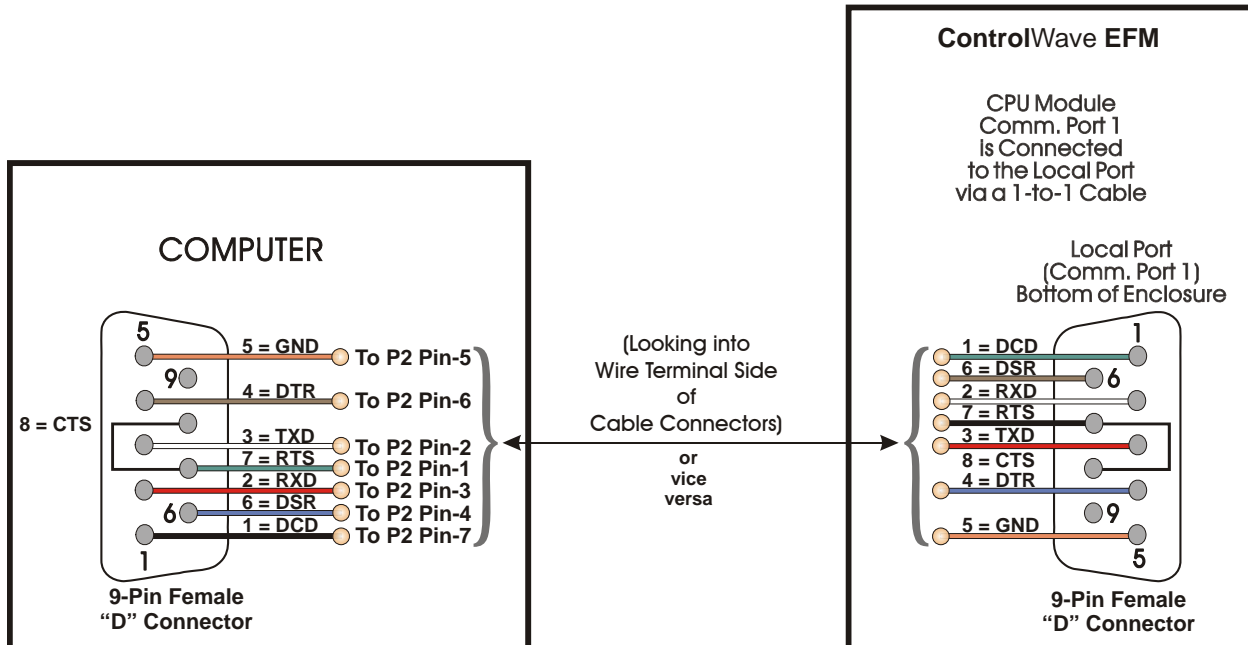
Figure 2-13A - PC Connected to Control Wave **EFM via D-Type Local Port**
(Use Null Modem Cable - Bristol Part Number 392843-01-3)
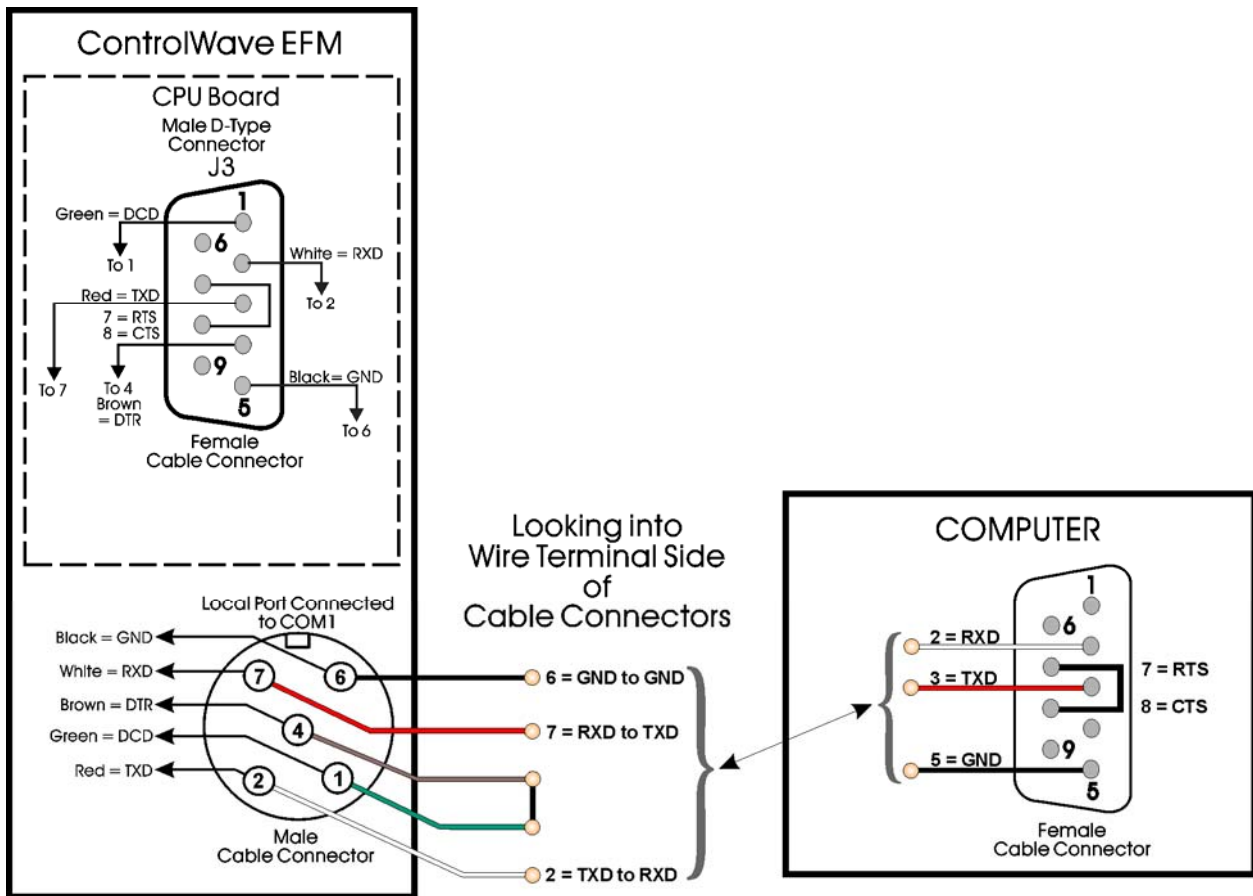
Figure 2-13B - PC Connected to Control Wave **EFM via Circular Local Port**
Bristol Cable Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Cable Part Number 395402-02-6 = 25 Foot Comm. Cable

RS-485 Ports
ControlWave **EFM** can use an RS-485 communication port for local network communications to multiple nodes up to 4000 feet away. Since this interface is intended for network communications, Table 2-5 provides the appropriate connections for wiring the master, 1st slave, and nth slave. Essentially, the master and the first slave transmit and receive data on opposite lines; all slaves (from the first to the "nth") are paralleled (daisy chained) across the same lines. The master node should be wired to one end of the RS-485 cable run. A 24-gauge paired conductor cable, such as Belden 9843 should be used. *Note: Only half-duplex RS-485 networks are supported.*

Receiver biasing and termination as well as 2-wire or 4-wire selection are enabled by eight-position DIP-Switches situated on the CPU Module and Expansion Communications Modules (ECOM) as follows: COM3: CPU Module Switch SW3, COM5: ECOM1 Switch SW1, and COM9: ECOM2 Switch SW1. An illustration of the CPU Module's male 9-pin D-type connectors is provided in Figure 2-11. Table 2-4A provides the connector pin assignments for CPU port COM3, ECOM1 port COM5 & ECOM2 port COM9. Table 2-6 provides the RS-485 termination and loopback control Switch Settings for the RS-485 Ports.

To ensure that the "Receive Data" lines are in a proper state during inactive transmission periods, certain bias voltage levels must be maintained at the master and most distant slave units (end nodes). These end nodes also require the insertion of 100-Ohm terminating resistors to properly balance the network. Secondary Communication Board switches must be configured at each node to establish proper network performance. This is accomplished

by configuring CPU Bd. Switch SW3 and/or ECOM Switch SW1 (COM6/COM9) so that the 100-Ohm termination resistors and biasing networks are installed at the end nodes and are removed at all other nodes on the network (see Table 2-6).

Table 2-5 - RS-485 Network Connections
(see Table 2-4A **Control**Wave **EFM** RS-485 Port Pin # Assignments)

From Master	To 1st Slave	To nth Slave
TXD+	RXD+	RXD+
TXD-	RXD-	RXD-
RXD+	TXD+	TXD+
RXD-	TXD-	TXD-
GND/ISOGND*	GND/ISOGND*	GND/ISOGND*

* ISOGND with Isolated RS-485 Ports Only!

Note: Pins 1, 2, 3, 4 & 9 of BBI Series 3305, 3310, 3330, 3335 & 3340 RTU/DPC RS-485 Comm. Ports are assigned as follows: 1 = TXD+, 2 = TXD-, 3 = RXD+, 4 = RXD- & 9 = ISOGND.

Table 2-6 - CPU Bd. Switch SW3 for COM3 & ECOM Bd. Switch SW1 for COM5/9 Loopback & Termination Control

SWITCH #	RS-485 Function Switch ON	Setting
1	TX+ to RX+ Loopback	ON - for Half Duplex Network or Diagnostics
2	TX- to RX- Loopback	ON - for Half Duplex Network or Diagnostics
3	100 Ohm RX+ Termination	ON - End Nodes Only
4	100 Ohm RX- Termination	ON - End Nodes Only
5	N/A	N/A
6 (see note 2)	Slew Rate ISO485 ONLY	ON - Slow Rate Enabled OFF - Fast Rate Enabled
7	RX+ Bias (End Node)	ON - End Nodes Only
8	RX- Bias (End Node)	ON - End Nodes Only

Note 1: Closed = Switch set ON   Note 2: Switch SW3 (COM3) = N/A

2.3.3.4 Piggy-back Spread Spectrum Modem (Radio) Port (see Appendix D)

An optional Spread Spectrum Modem (Radio) is available on each Expansion Communications Module (mounted piggy-back) and is assigned port status as follows: COM6 for ECOM1 and COM10 for ECOM2. There are two unique radios offered. These radios will only communicate with their own brand of radio, i.e., FreeWave radios are not compatible with MDS radios. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the radio at a rate up to 115.2kHz.

These radios are supplied in kit form with all the hardware required for user installation onto an Expansion Communications Module. Figure 2-14 shows both versions of radios mounted on the Expansion Comm. Module. Radios are user installed onto the ECOM Module (see Figure 2-14) and their associated Ports are setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView.

FreeWave® Spread Spectrum Wireless Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).
Microwave Data System Inc. MDS TransNET OEM™ Spread Spectrum Data Transceiver:
Operates in the 902 to 928 MHz range (20 miles).

Installation steps 1 through 3 below support user installation and configuration of a Spread Spectrum Modem.

1. Mount the radio (Spread Spectrum Modem) onto the Expansion Comm. Module. Remove the nut and washer from the internal coaxial RF cable supplied with the ECOM Module. Remove the plug from the front of the ECOM Cover and insert the in-ternal coaxial RF cable's SMA connector (straight end with flat area on top) through the rear of the ECOM Cover. Install the washer and nut to secure the internal coaxial RF cable to the front of the ECOM Cover. Install the other end of the internal coaxial RF cable to the radio's RF antenna connector. Install the Expansion Comm. Module into Slot 3 or 4 of a base **Control**Wave **EFM** unit.

2. Install the user supplied coaxial RF cable between the ECOM cover's SMA connector (installed in step 1) and the remote antenna. Note: A Polyphaser may be placed between the antenna and the radio's SMA connector via two user supplied RF cables.

3. For **FreeWave Radio**: Follow the Tuning Transceiver Performance" section of the FreeWave Technologies Inc. FreeWave Spread Spectrum Wireless Data Transceiver User Manual to configure the radio.

   For **MDS Radio**: Refer to section 3.3 "Initial Power-Up & Configuration" within the MDS TransNet OEM Integration Guide and if necessary for more information on connecting a PC terminal and preparing it for use, refer to section 9.0 "PROGRAMMING REFERENCE."

Note:
To invoke the setup program, connect the radio (via ECOM1 port COM4 or ECOM2 port COM8) to a terminal program (such as HyperTerminal) via a null modem cable (see Figures 2-12, 2-13A & 2-13B), put the radio into setup mode and set the parameters for the terminal to those of Table 2-7. The setup program is invoked by connecting Pins 1 and 2 of ECOM Bd. Jumper Post JP2.

Table 2-7 - Radio Setup Menu Terminal Settings

PARAMETERS	SETTINGS
Baud Rate	19,200
Data Rate	8
Parity	None
Stop Bits	1
Parity Check	None/Off
Carrier Detect	None/Off
Flow Control	Xon/Xoff

2.3.3.5 Piggy-back 56K PSTN Modem Port (see Appendix D)

An optional 56K PSTN Hayes type Modem can be mounted piggy-back on each Expansion Communications Module and is assigned port status as follows: COM7 for ECOM1 and COM11 for ECOM2. The Model MT5634SMI Modem module is manufactured by MultiTech System and can be user configured for PSTN operation. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the modem at a rate up to 115.2kHz.

MDS (Transnet) Radio Kit Parts
A = 6-32 x .188" Pan Head Screw (Qty. 4)
B = 6-32 x .313" F/F Standoff (Qty. 4)
C = 6-32 x .250" Pan Head Screw (Qty. 4)
D = Transnet Radio Cable (with Nut and Washer)
E = MDS Transnet Radio Module

NOTE:
ECOM Module Comm. Ports
4/8 (RS-232) & 5/9 (RS-485)
are wired the same as
CPU Module Comm. Ports

OPTION
Populated
by
Order

If In Slot #3
Comm. Port
Assignments
If In Slot #4

Modem Kit Parts
K = Nylon Support Post
L = Modem

FreeWave Radio Kit Parts
F = 2-56 x .188" Pan Head Screw (Qty. 3)
G = 2-56 x .250" F/F Standoff (Qty. 3)
H = 2-56 x .250" Pan Head Screw (Qty. 3)
I = FreeWave Radio Cable (with Nut and Washer)
J = FreeWave Radio Module
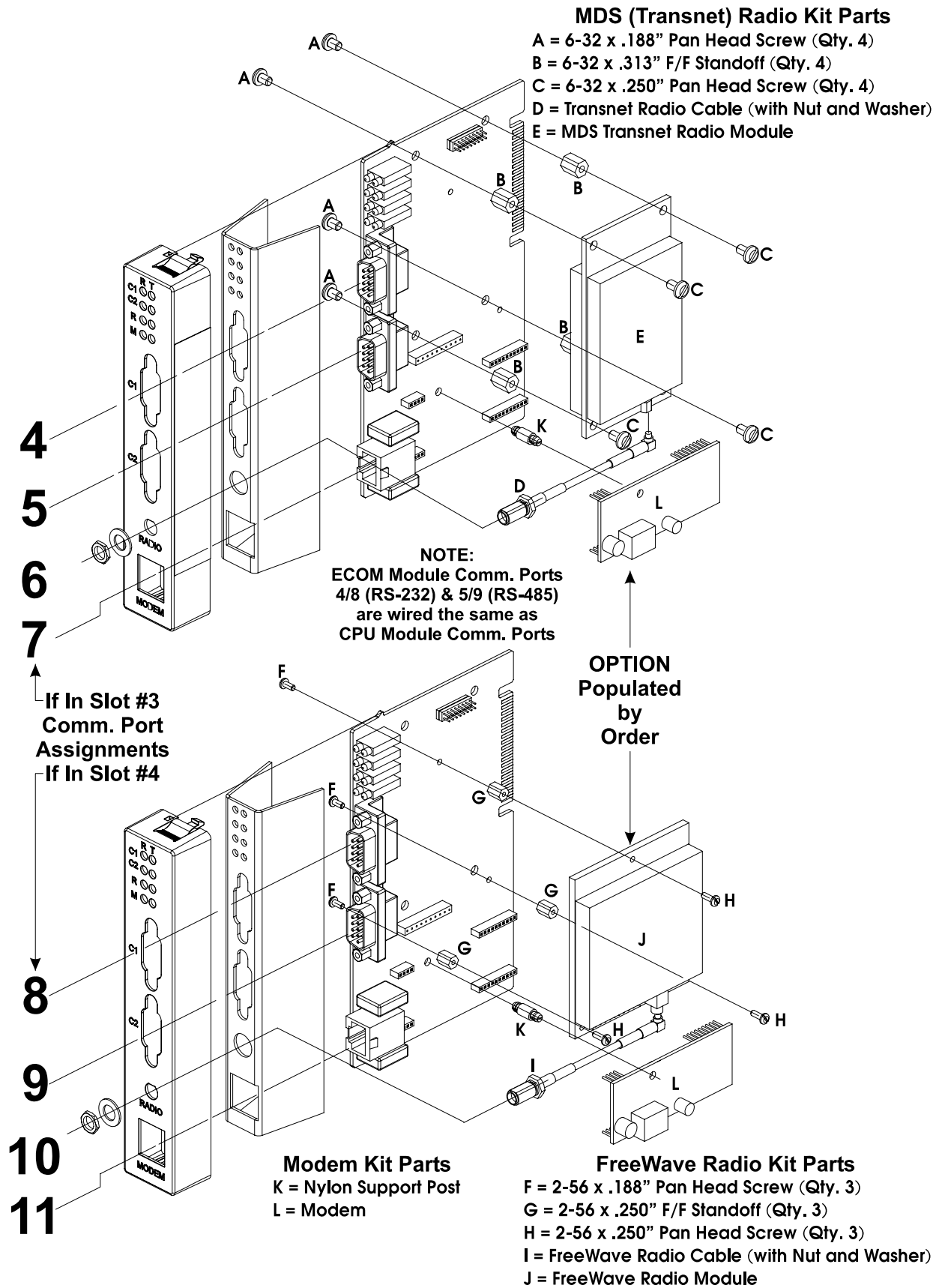
Figure 2-14 - Expansion Comm. Module Radio/Modem Installation Diagram

Modems are supplied in kit form with all the hardware required for user installation onto an Expansion Communications Module. Figure 2-14 shows the modem mounted on the Expansion Comm. Module.

Modems are user installed onto the ECOM Module (see Figure 2-14) and their associated Ports are setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView. A Terminal Emulation program such as HyperTerminal is used to profile the modem via AT commands. Users typically use AT commands only when checking the modem's active or stored profile or when reconfiguring a modem, e.g., to turn auto answer on or off, etc.

MultiTech Modems are pre-configured using the following 7 steps prior to being shipped.

- Enable modem setup by setting ECOM Board jumper JP2 to 2-3.
- Connect via HyperTerminal (Parameters = 9600, 8, N, 1, None) to ECOM port C1 using the null modem cable (see Figure 2-12A or 2-13).
- Send Factory Default = AT&F0
- Disable Flow Control = AT&K0
- Set Baud using AT Command: AT$SB9600, or whatever baud rate you require.
- Write to Memory. = AT&W
- Disable setup mode. Park JP2 (no connection)

Note:
The modem can be reconfigured via AT commands using a terminal program (such as HyperTerminal). Connect Pins 2 and 3 of ECOM Bd. Jumper Post JP2 via a Suitcase Jumper. Connect the modem (via ECOM1 port COM4 or ECOM2 port COM8) to the PC via a null modem cable (see Figure 2-12A).

Publicly Switched Telephone Network (PSTN) Hookup
A PSTN using a master and three remote Process Automation Controllers (each equipped with a PSTN modem) is shown in Figure 2-15. A connection to the PSTN is made using a cable having standard telephone connectors at each end. One end of the cable plugs into the ECOM's RJ11 connector jack while the other end plugs into a telephone company RJ11 wall jack. The telephone company provides the necessary subscriber loops at its central system along with the phone numbers for each destination.

Warning
Only one modem should be connected to each drop. If an attempt is made to parallel two or more modems across a single drop, an impedance mismatch will occur and the quality of the signal will be adversely affected. Modems will not provide reliable communications under these conditions.

An application consisting of a single master and a single remote requires only one of the remote connections shown in Figure 2-15.

The 56K PSTN Modem is FCC-approved for use with public telephone lines. Before placing a modem in operation, the following items should be checked to insure that all FCC requirements are met:

- Connections to party line service is subject to state tariffs.

- Connection to telephone company provided coin service (central office implemented systems) is prohibited.
- The equipment compliance information is summarized as follows:

Complies with Part 68 FCC Rules.
Contains device with FCC Registration Number: AU7-USA-25814-M5-E
Ringer Equivalence Number (REN): 0.3B

Note: The sum of all the RENs on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

- Any direct connections to PSTN lines must be made through standard plugs and jacks as specified in the FCC rules. The PSTN line connector plugs into J1 on the modem. Notify your telephone company that the jack (connector) required for your device is one of the following: *Note: The Jack provided on the Modem (J1) is a 6-Pin TLECO RJ-11.* The connections to the modem are Pin 3 PSTN-Tip, and Pin 4 PSTN-Ring.

  USOC: RJ11C or USOC: RJ11W

- After the telephone company has installed the above jack, connect the modem to your equipment by inserting the appropriate equipment interface cable (plugs) into the modem jack and the wall jack.
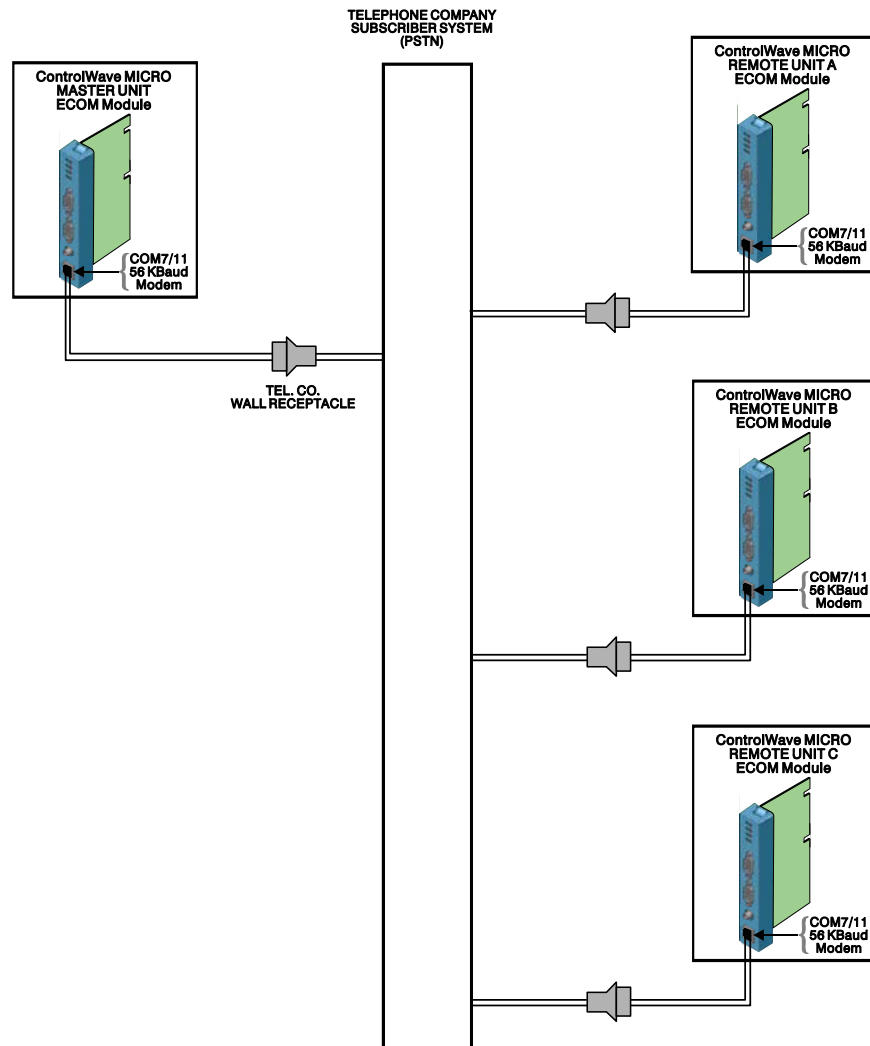
Figure 2-15 - Field Connections for Control Wave **EFM on Basic PSTN**

PHONE CONNECTOR

MODULAR PLUG CONNECTIONS

6

1

1. WHITE
2. BLACK
3. RED   (PSTN - TIP)
4. GREEN   (PSTN - RING)
5. YELLOW
6. BLUE
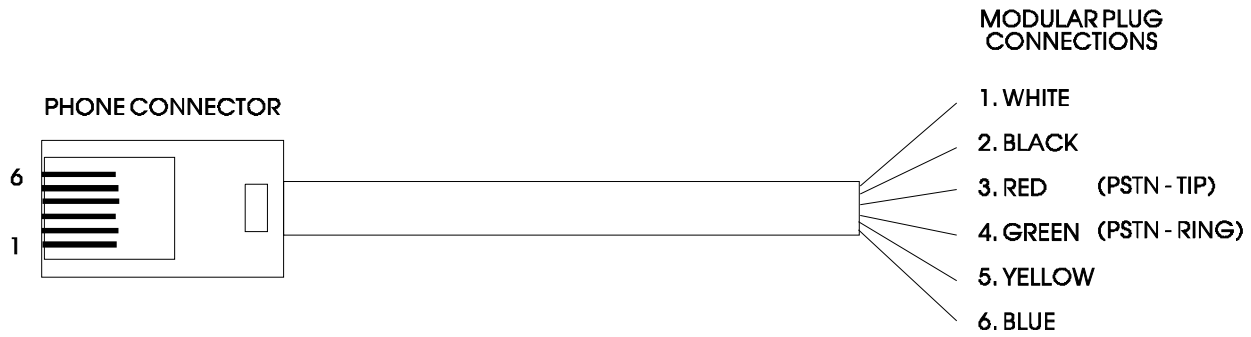
Figure 2-16 - Wiring for Phone Cord Connector

2.3.3.6 Radio Ready and External (Case Mounted) Modem or Radio

A wide selection of modems and radios are offered. The **Control**Wave **EFM** is factory shipped with a user selected radio or modem installed within the enclosure (beneath the Battery Mounting Bracket) or as a radio ready unit, i.e., ready for field installation of a Bristol supplied radio. The installer must ensure that the remote antenna (associated with a case mounted radio) is properly installed and connected.

Information on operating and configuring a BBI supplied radio or modem is contained in documentation authored by the unit's manufacturer. A list of reference manuals is provided in the Table of Contents under the topic REFERENCED OEM MANUAS.

2.3.4 I/O Module Installation & Wiring

ControlWave **EFM** Base Assembly chassis' are available with a Backplane Assembly that supports up to 2 or 6 I/O Modules (for 4-Slot and 8-Slot base units, respectively). I/O Modules may reside in Slots 3 through 4 of the 4-Slot base unit and Slots 3 through 8 of the 8-Slot base unit.. In lieu of an I/O Module, an Optional Expansion Communications Modules may reside in either Slots 3 or 4 (or both) of a **Control**Wave **EFM** Base Assembly. Figure 2-17 shows **Control**Wave **EFM** Backplane Slot assignments.

2.3.4.1 Installation of I/O Modules

If installing one or more I/O Modules into an already operational unit, the unit must be taken off-line. Processes associated with the **Control**Wave **EFM** in question must be shut down, switched over manually or handled by another controller. Module installation and removal may not be performed while the unit is powered. Additionally, the application load in **Control**Wave Designer must be configured to accept any new I/O Module(s) and then the new application load must be downloaded before the new I/O Module(s) can become operational. Hardware configuration should take place with power disconnected until the entire unit has been physically installed, configured and wired.

Perform steps 1 through 6 below for each I/O Module. I/O Modules are provided with a removable Cover. The I/O Module Cover snaps on or off to provide access to the unit's I/O connectors.

1. Remove the I/O Module and associated I/O Module Cover from the shipping carton.

2. I/O Modules are available that support local terminations (field wiring connected directly to the I/O Module's removable Terminal Blocks). When installing wiring in conjunction with I/O Modules, install the field wiring between the I/O Module's

removable Terminal Block connectors and field devices (see Figure 2-18). Use AWG 14 or smaller wire, (consult with the field device manufacturer for recommendations). Leave some slack and plan for wire routing, identification, maintenance, etc. The bundled wires are to be routed in/out through the bottom of the I/O Module Assembly between the Terminal Block Assembly and the Terminal Housing Assembly. All I/O wiring should be routed in/out of the enclosure through 1" NPT Conduit Hub.

Non-Isolated I/O Module wiring information is provided in the following sections:

Section 2.3.4.4 = Digital I/O Module (12 DI & 4 DO)
Section 2.3.4.5 = Analog I/O Module (6 AI & 2 AO) and Analog Input Module (6 AI)
Section 2.3.4.6 = High Speed Counter Module (4 HSC)
Section 2.3.4.7 = Mixed I/O Module (6 DI/DO, 4AI, 2 HSC & 1 optional AO

Note: The ControlWave Loop Power Supply can be used to provide regulated and isolated 24Vdc field power for externally powered non-isolated I/O see PIP-ControlWaveLS).

3. Align the I/O Module with the assigned I/O Slot and install the unit into the Chassis. Make sure that the I/O Module Cover snaps into the applicable notches in the Chassis Assembly.

4. Plug the Local Cable Assemblies onto the appropriate I/O Module connectors.

5. When two I/O Modules have been installed into the Chassis (with field wiring), a Bezel Assembly should be installed to cover, protect and dress the unit.

4-Slot Base Backplane

P1 = PSSM Module Connector (BP Slot #1)
P2 = CPU Module - PSSQ/CPU Connector (BP Slot #2)
P3 = CPU Module - I/O Bus Interface Connector (BP Slot #2)
P4 = Exp. Comm. Module #1 or I/O Module #1 (BP Slot #3)
P5 = Exp. Comm. Module #2 or I/O Module #2 (BP Slot #4)
P10 = Exp. Backplane Connector

Note: Slots 1 through 4 Identical to 4-Slot Base Backplane

8-Slot Base Backplane

P1 = PSSM Module (BP Slot #1)
P2 = CPU Module - PSSQ/CPU (BP Slot #2)
P3 = CPU Module - I/O Bus (BP Slot #2)
P4 = Exp. Comm. Module #1 or I/O Module #1 (BP Slot #3)
P5 = Exp. Comm. Module #2 or I/O Module #2 (BP Slot #4)
P6 = I/O Module #3 (BP Slot #5)
P7 = I/O Module #4 (BP Slot #6)
P8 = I/O Module #5 (BP Slot #7)
P9 = I/O Module #6 (BP Slot #8)
P10 = Exp. Backplane Connector

Figure 2-17 - ControlWave EFM Slot Assignments

6. Using a PC equipped with 'ControlWave Designer' and 'OpenBSI' software, configure the ControlWave EFM to accept the new I/O Module (and any other modules that have been added or removed) and then download the application load into the ControlWave EFM CPU's System FLASH and/or SDRAM (see Section 2.4.1). For new installations, this step can be skipped until the unit has been wired and power applied.
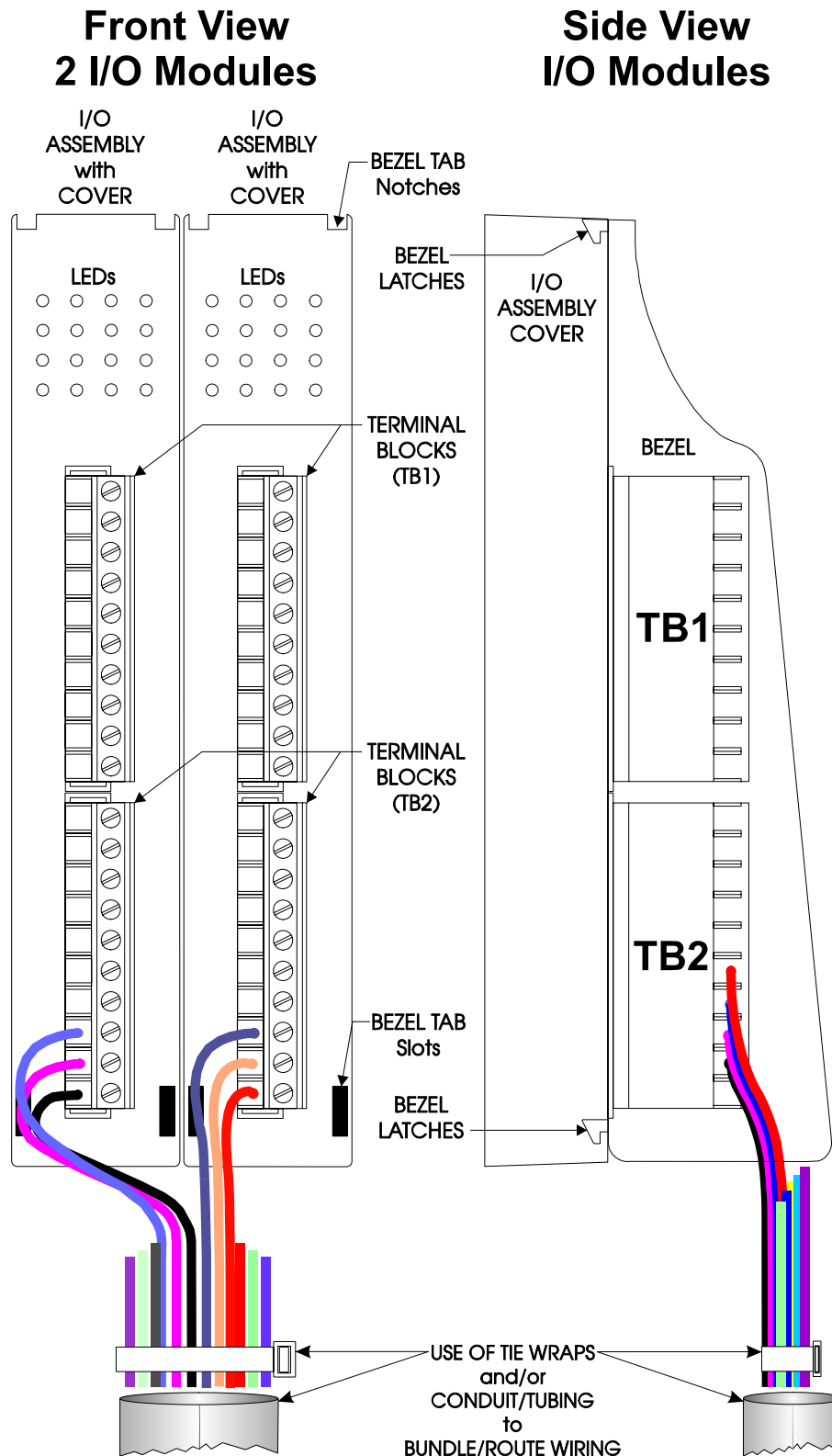
Figure 2-18 - I/O Module (Local Termination) Wire Routing

2.3.4.2 I/O Wire Connections

ControlWave **EFM** electronic flow computers utilize compression-type terminals that accommodate up to #14 AWG wire. A connection is made by inserting the wire's bared end (1/4" max) into the clamp beneath the screw and securing the screw. The wire should be inserted fully so that no bare wires are exposed to cause shorts. If using standard wire, tin the bare end with solder to prevent flattening and improve conductivity.

Allow some slack in the wires when making terminal connections. The slack makes the connections more manageable and minimizes mechanical strain on the terminal blocks.

2.3.4.3 Shielding and Grounding

The use of twisted-pair, shielded and insulated cable for I/O signal wiring will minimize signal errors caused by electromagnetic interference (EMI), radio frequency interference (RFI) and transients. When using shielded cable, all shields should only be grounded at one point in the appropriate system. This is necessary to prevent circulating ground current loops that can cause signal errors.

2.3.4.4 Non-isolated Digital Input/Output Module (see Figure 2-19)

ControlWave **EFM** non-isolated Digital Input/Output Modules contain field interface circuitry for up to 12 Digital Inputs and 4 Digital Outputs. Surge Suppression and signal conditioning is provided for each DI. DO circuits consist of an open drain MOSFETs and Surge Suppression. The DI filter time is 15 milliseconds. DI/O Modules con-sists of a Digital Input/Output PCB with two 10-point Terminal Block Assemblies (for local termination), 14 Configuration Jumpers, an LED Board with 16 Status LEDs (one for each point) and a Cover Assembly. The DI/O Board mates with the Backplane PCB via a 36-pin gold plated card edge connector.

DI/O Modules provide internally sourced DI operation for Dry Contacts pulled internally to 3.3Vdc when the field input is open. Each DI is protected with a surge suppressor. DI filtering is 15 milliseconds. The four DOs are composed of open drain MOSFETs and surge suppressors. The DOs sink current to system ground of the DI/O Board.

2.3.4.4.1 Digital Input/Output Configurations

Digital Input/Output Modules provide 12 individually field configurable DIs and 4 non-configurable externally powered DOs. Each DI may be individually set to provide either a 2mA or 60uA source current via Configuration Jumpers W1 through W12. Open drain MOSFETs associated with each DO provide up 100mA each @ 30Vdc to an externally powered device. DI/O Module Configuration Jumpers W1 through W14 must be set per Table 2-8. Field wiring assignments are provided in Figure 2-19.

Table 2-8 - Non-Isolated DI/O Module Jumper Assignments

Jumper	Purpose	Notes
W1 - W12	Configures DI1 through DI12 (respectively)	Pins 1-2 installed = 2mA Source Current Pins 2-3 installed = 60uA Source Current
W13	LED Enable	Pins 1-2 installed = Enables LEDs Manually Pins 2-3 installed = Enable LEDs via software
W14	Program Serial EEPROM	Factory Use ONLY
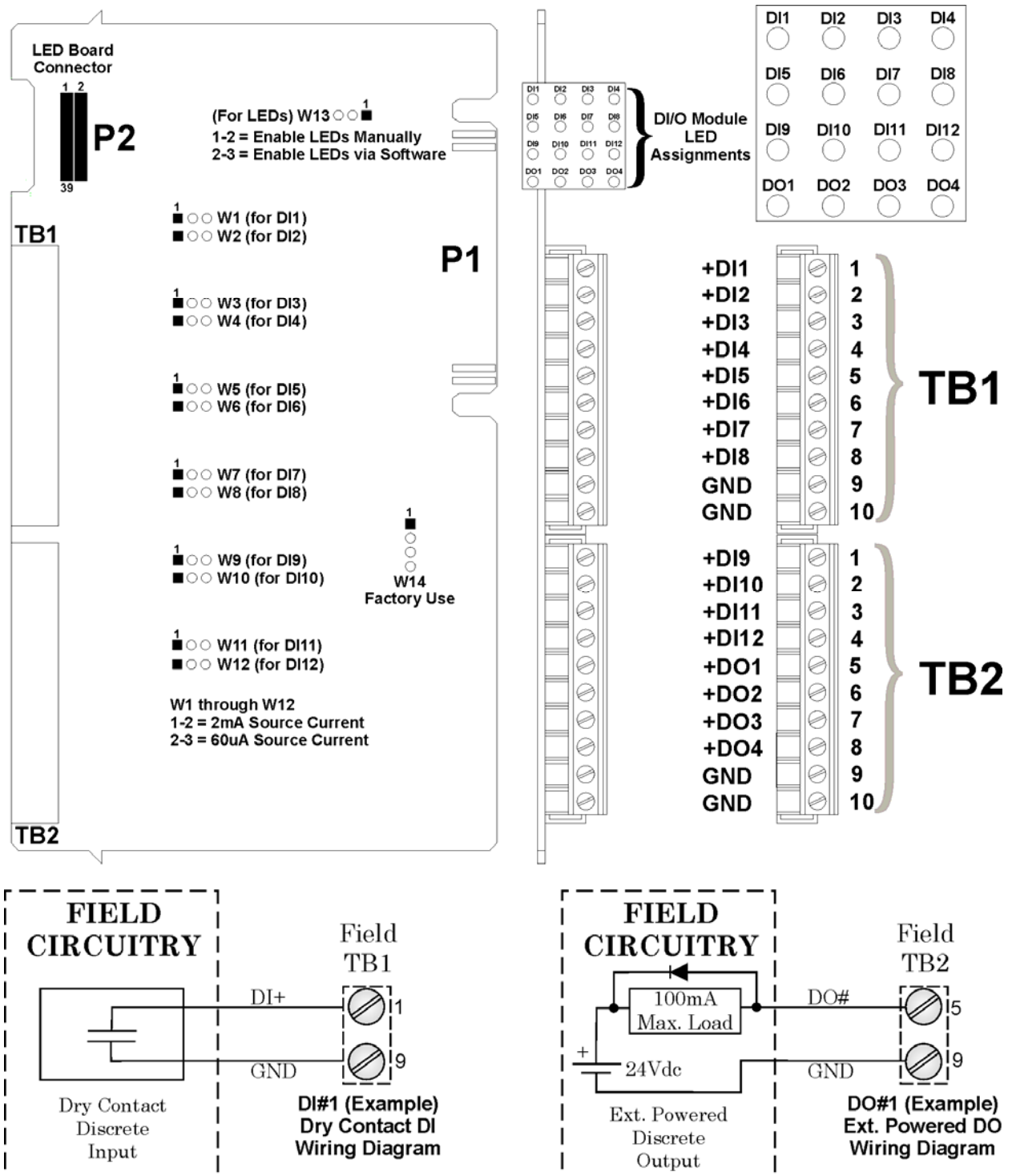
Figure 2-19 - Non-Isolated DI/O Module Configuration Diagram

2.3.4.5 Non-isolated Analog Input/Output & Analog Input Modules (see Figure 2-20)

Analog Input/Output Modules support six 4-20mA or 1-5 Vdc single ended analog inputs and optionally, two independently configurable 4-20mA or 1-5 Vdc analog outputs. AI/O Modules consists of an Analog Input/Output PCB with two 10-point Terminal Block Assemblies (for local termination), 12 Configuration Jumpers and a Cover Assembly. The AI/O Board mates with the Backplane PCB via a 36-pin gold plated card edge connector. Analog Input Modules are identical to AI/O Modules but have a depopulated AO section.

Each AI signal is channeled through signal conditioning circuitry (that provides a 2 Hertz low pass filter), a transorb for surge suppression, multiplexer, and an A to D Converter (ADC).
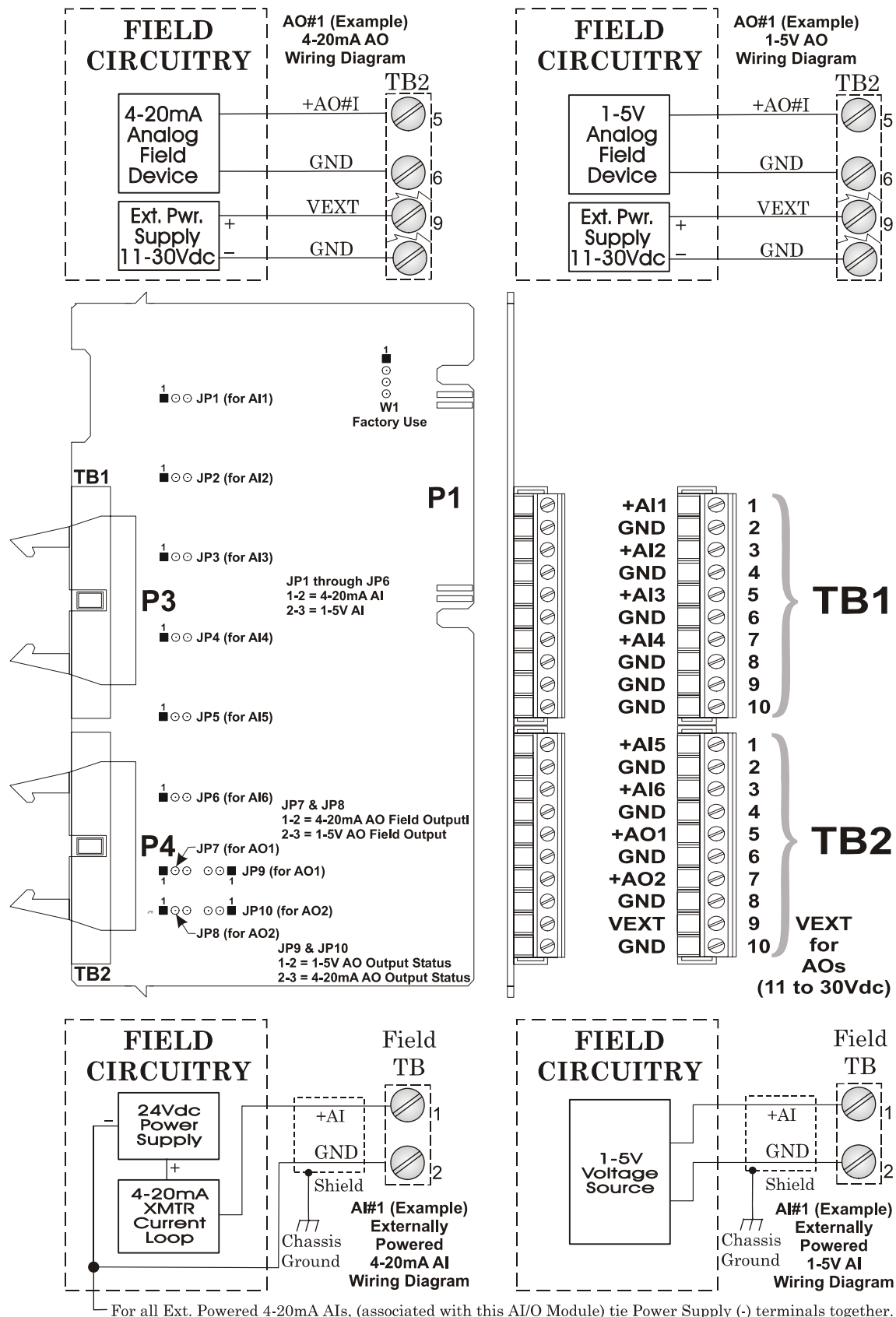
Figure 2-20 - Non-isolated AI/O & AI Module Configuration Diagram

The Analog Output circuit consists of a 12-bit resolution Digital to Analog Converter (DAC), a V to I circuit, and a V to V circuit. The 12-bit DAC dives the V to I circuitry. A scaling circuit within the V to I circuit drives the V to V circuitry. V to I and V to V circuitry are powered by an external power source.

A CPLD generates the control signals for the ADC, multiplexer, EEPROM, Bus Interface and E²PROM that contains the calibration data.

2.3.4.5.1 Analog Input/Output Configurations

AI/O and AI Modules are provided with Configuration Jumpers that accommodate configuration of each of the six Analog Inputs. Analog Input can be individually configured for 1-5V or 4-20mA operation. Field wiring assignments are provided in Figure 2-20.

Note:
Cable shields associated with AI wiring should be connected to the Control Wave **EFM's Chassis Ground. Multiple shield terminations will require a user supplied copper ground bus. This ground bus must be connected to the Control**Wave **EFM's Chassis Ground Lug (using up to a #4 AWG wire size) and must accommodate a connection to a known good Earth Ground (in lieu of a direct connection from the Ground Lug) and to all AI cable shields. Shield wires should use an appropriate Terminal Lug and should be secured to the copper bus via industry rugged hardware (screw/bolt, lockwasher and nuts).**

Analog Input/Output Modules are provided with two Analog Outputs that are individually jumper configurable for 1-5V or 4-20mA AO operation. The maximum external load that can be connected to the 4-20mA output is 250 ohms (with an external 11V power source) or 650 ohms (with an external 24V power Source). The maximum external load current for the 1-5V output is 5mA (with an external 11 to 30 V power source). AO operation requires an 11 to 30Vdc power source connected to the VEXT terminal of the AI/O Module.

Table 2-9 - Analog Input/Output/Analog Input Module Jumper Assignments

Jumper	Purpose	Notes
JP1 - JP6	Configures AI1 through AI6 (respectively)	Pins 1-2 installed = 4-20 mA AI Pins 2-3 installed = 1-5V AI
JP7	AO1 Field Output	Pins 1-2 installed = 4-20 mA AO Pins 2-3 installed = 1-5V AO
JP8	AO2 Field Output	Pins 1-2 installed = 4-20 mA AO Pins 2-3 installed = 1-5V AO
JP9	AO1 Output Status	Pins 1-2 installed = 1-5V AO Pins 2-3 installed = 4-20 mA AO
JP10	AO2 Output Status	Pins 1-2 installed = 1-5V AO Pins 2-3 installed = 4-20 mA AO
J1	Configure ISP Connector	Factory Use ONLY
W1	Program Serial EEPROM	Factory Use ONLY

* Note: JP7 & JP9 Operation Must Match, i.e., both set for 1-5V or 4-20mA
          JP8 & JP10 Operation Must Match, i.e., both set for 1-5V or 4-20mA

2.3.4.6 Non-isolated High Speed Counter Input Module (see Figure 2-21)

Non-isolated High Speed Counter Input (HSC) Modules provide a total of 4 inputs provided with surge suppression bandwidth limiting and 20 microsecond (50kHz) filtering. HSC Module inputs may be individually field configured with contact debounce circuitry enabled or disabled and for 2mA or 200uA (low power) operation. When debounce circuitry is enabled, spurious pulses caused by relay contact bounce are reduced with filters. HSC

Modules consists of a High Speed Counter PCB with two 10-point Terminal Block Assemblies (for local termination), 14 Configuration Jumpers, an LED Board with 4 Status LEDs (one for each point) and a Cover Assembly. The HSC Board mates with the Backplane PCB via a 36-pin gold plated card edge connector.
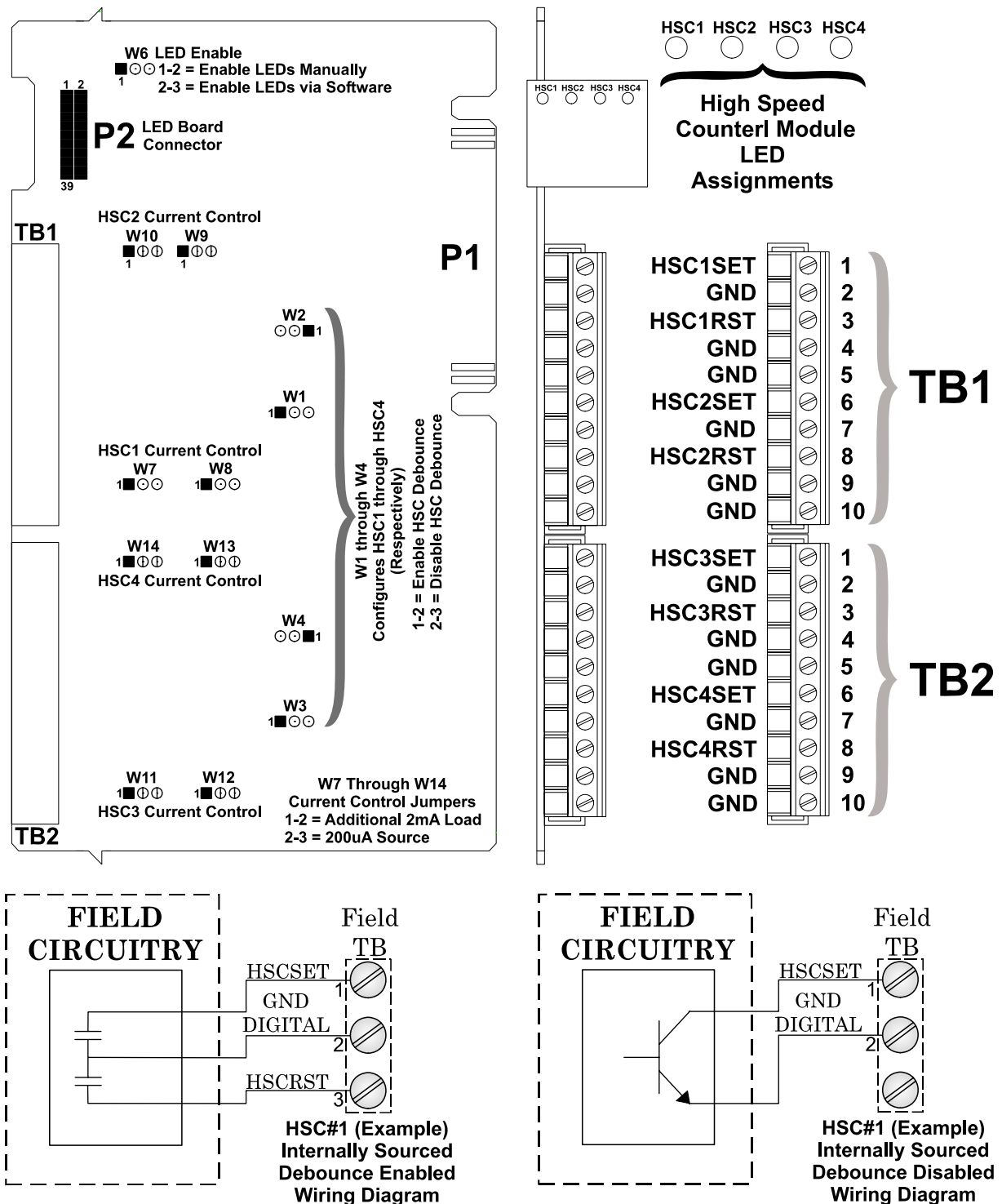
Figure 2-21 - Non Isolated HSC Module Configuration Diagram

High Speed Counter Input Modules contain conditioning circuitry consisting of a debounce circuitry followed by a one shot pulse circuit that generates a 65 microsecond ±10% pulse and limits the maximum frequency of an input signal to 15kHz. Field inputs can be driven

signals, or relay contacts. A serial EEPROM contains HSC Board serialization data. Each input of the HSCI Module is configured as a 16-bit high-speed counter.

2.3.4.6.1 High Speed Counter Configurations

HSC Modules provide a total of 4 HSC inputs with surge protection. HSC Module Configuration Jumpers W1 through W14 must be set per Table 2-10.

Table 2-10 - Non Isolated High Speed Counter Module Jumper Assignments

Jumper	Purpose	Notes
W1 - W4	Configures HSC1 through HSC4 (respectively)	Pins 1-2 installed = Enables HSC Debounce Pins 2-3 installed = Disabled HSC Debounce
W5	Program Serial EEPROM	Factory Use ONLY
W6	LED Enable/Disable	Pins 1-2 installed = Enables LEDs Manually Pins 2-3 installed = Enable LEDs via software
W7 & W8	HSC1 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load
W9 & W10	HSC2 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load
W11 & W12	HSC3 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load
W13 & W14	HSC4 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load

Field wiring assignments are provided in Figure 2-21.

2.3.4.7 Non-isolated Mixed I/O Module (see Figures 2-22 & 2-23)

Non-isolated Mixed I/O Modules provide a total of 6 individually field configurable Digital Inputs/Outputs, 4 Analog Inputs, 2 High Speed Counter Inputs and 1 optional Analog Output. I/O circuitry is similar to those utilized on the I/O Modules discussed in sections 2.3.4.4 through 2.3.4.6.

Surge Suppression and signal conditioning is provided for each DI. DO circuits consist of an open drain MOSFETs and Surge Suppression. Mixed I/O Modules provide internally sourced DI operation for Dry Contacts pulled internally to 3.3Vdc when the field input is open. Each DI is protected with a surge suppressor. DI filtering is 15 milliseconds. DOs are composed of open drain MOSFETs and surge suppressors.

Mixed I/O Module AIs are independently configurable for 4-20mA or 1-5 Vdc single ended operation. Each AI signal is channeled through signal conditioning circuitry (that provides a 2 Hertz low pass filter), a transorb for surge suppression, multiplexer, and an A-to-D Converter (ADC).

Non-isolated Mixed I/O Modules support a total of 2 HSC inputs provided with surge suppression, bandwidth limiting and 20 microsecond (50kHz) filtering. HSC inputs may be individually field configured with contact debounce circuitry enabled or disabled and for 2mA or 200uA (low power) operation. HSCs are supported by signal conditioning circuitry consisting of a debounce circuit followed by a one shot pulse circuit that generates a 65 microsecond ±10% pulse and limits the maximum frequency of an input signal to 15kHz. Field inputs can be driven signals, or relay contacts. Each input of the HSCI Module is configured as a 16-bit high-speed counter.
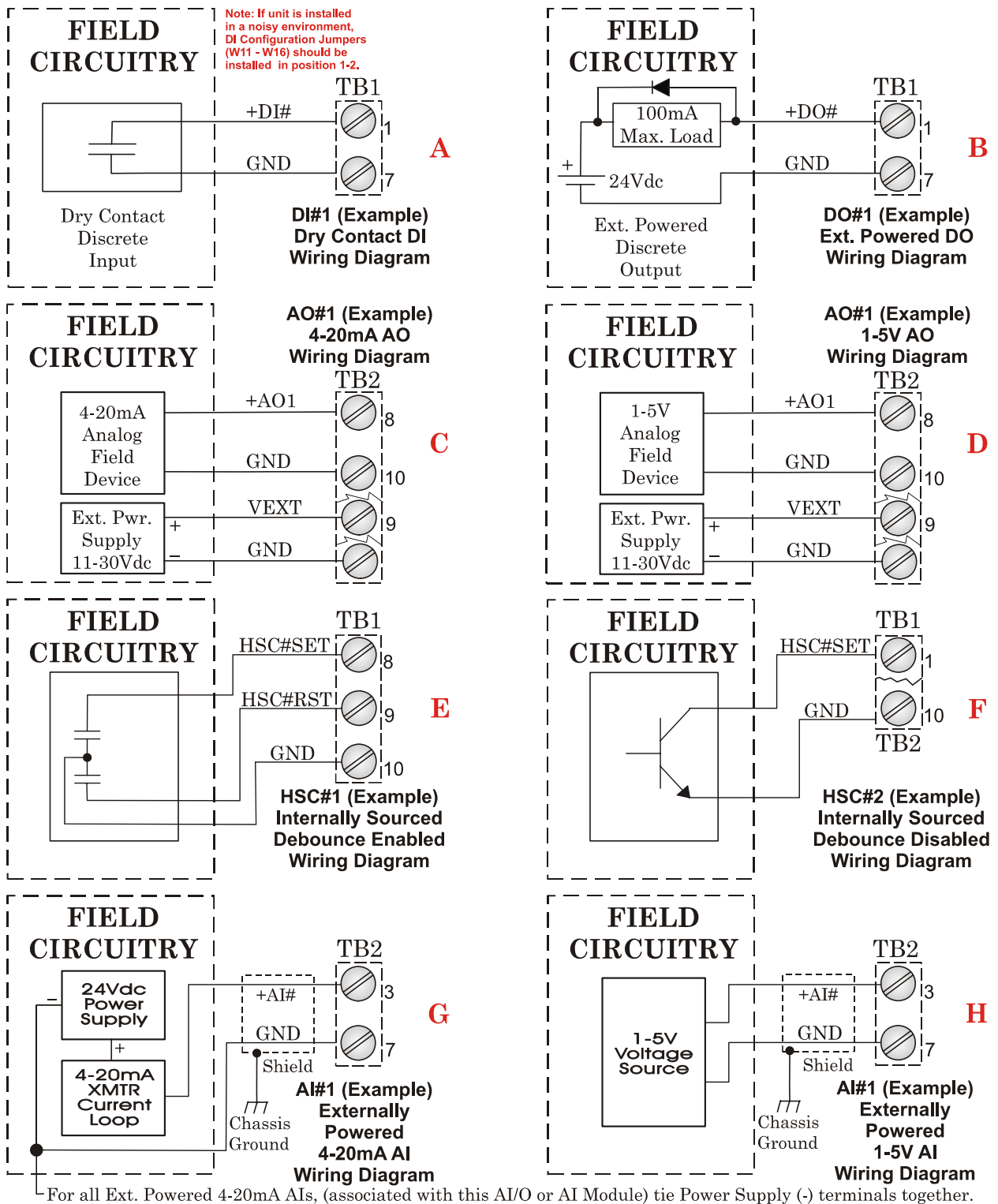
Figure 2-22 - Mixed I/O Module Wiring Diagram

Mixed I/O Modules optionally support one externally powered (VEXT = 11 to 30Vdc) analog output. AO Circuitry consists of a 12-bit resolution Digital to Analog Converter (DAC), a V to I circuit, and a V to V circuit. The 12-bit DAC drives the V to I circuitry. A scaling circuit within the V to I circuit drives the V to V circuitry. V to I and V to V circuitry are powered by an external power source.
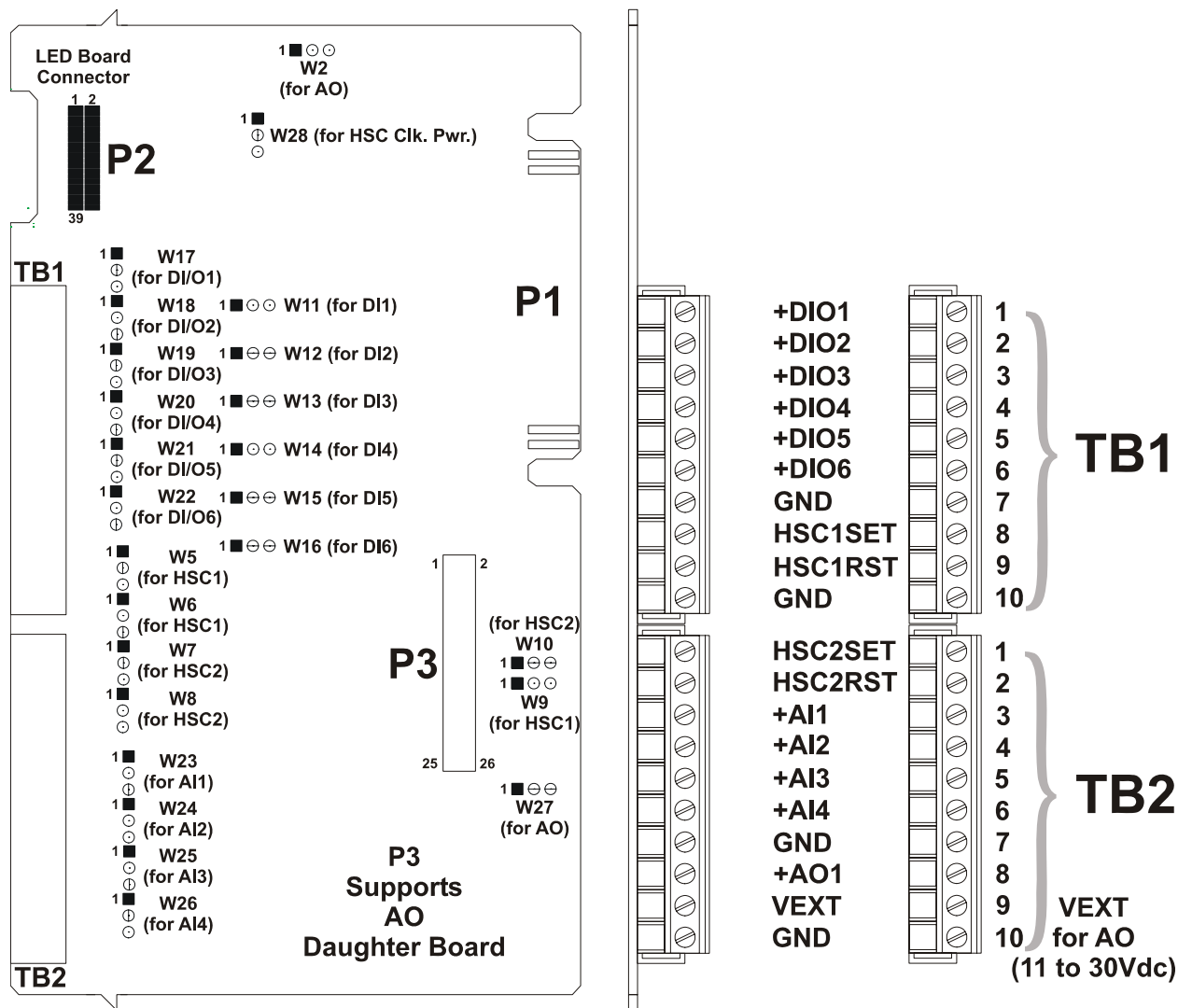
Figure 2-23 - Non Isolated Mixed I/O Module Configuration Diagram

2.3.4.7.1 Mixed I/O Module Configurations

Mixed I/O Module Configuration Jumpers W1 through W28 must be set per Table 2-11.

Table 2-11 - Non Isolated Mixed I/O Module Jumper Assignments

Jumper	Purpose	Notes
W1*	Configures optional AO for Voltage or Current Output	Pins 1-2 installed = AO set for Current Output Pins 2-3 installed = AO set for Voltage Output
W2	Configures optional AO for Voltage or Current Output	Pins 1-2 installed = AO set for Voltage Output Pins 2-3 installed = AO set for Current Output
W5 & W6	HSC1 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load
W7 & W8	HSC2 Current Control	Pins 1-2 installed = for additional 2mA load Pins 2-3 installed = 200uA Source no 2mA load
W9 & W10	Configures HSC1 and HSC2 Debounce (respectively)	Pins 1-2 installed = Enables HSC Debounce Pins 2-3 installed = Disabled HSC Debounce
W11 - W16	Configures DI1 through DI6 Current (respectively)	Pins 1-2 installed = 2mA Source Current Pins 2-3 installed = 60uA Source Current
W17 - W22	DI/O1 through DI/O6 Point Selection (respectively)	Pins 1-2 installed = Digital Input Operation Pins 2-3 installed = Digital Output Operation

Table 2-11 - Non Isolated Mixed I/O Module Jumper Assignments (Continued)

Jumper	Purpose	Notes
W23 - W26	Configures AI1 through AI4 (respectively)	Pins 1-2 installed = 4-20mA AI (250 ohm resistor in) Pins 2-3 installed = 1-5V AI
W27	AO Voltage Selection **Set W27 Pins 2-3 ALWAYS**	Pins 1-2 installed = N/A Pins 2-3 installed = External Field Voltage (TB2-9)
W28	HSC Circuitry Enable	Pins 1-2 installed = HSC Circuit Enable (Powered) Pins 2-3 installed = HSC Circuit Disabled

* = W1 located on optional AO Daughter Board

2.3.5 RTD Wiring

A 3-wire RTD may be provided with the **Control**Wave **EFM**. Connector TB2 on the System Controller Module accommodates a removable three-wire Terminal Block (similar to TB1). This connector accommodates a 100-ohm platinum bulb using the DIN 43760 curve. **Control**Wave **EFM**'s utilize the common three-wire configuration. In this configuration, the Return lead connects to RTD- and the two junction leads (Sense and Excitation), connect to RTD+ and RTD EXC. Connection between the RTD and System Controller Module is wired as follows:

Table 2-12 - RTD Connections to System Controller Connector TB2

TB2 Pin	Signal	Function
1	RTD EXC	Excitation
2	RTD+	Sense
3	RTD-	Return

Never ground the RTD Cable Shield at both ends or allow it to come in contact with metallic or conductive conduit as multiple ground paths could result and cause RTD input errors.
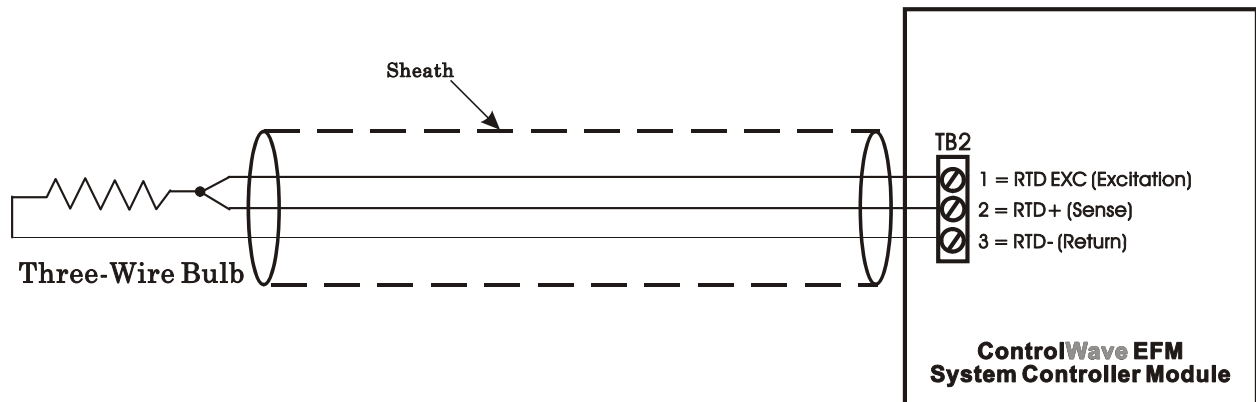
Figure 2-24 - 3-Wire RTD Temperature Input Wiring

To install the RTD Probe, screw the Fitting Body into the thermowell with a 7/8"open-end wrench. While applying pressure against the sheath to force the Tip of the RTD Probe into the bottom of the thermowell (so that the Probe Tip is in contact with the thermowell), tighten the Nut (9/16" open-end wrench) against the 7/8" Fitting Body (see Figure 2-25).
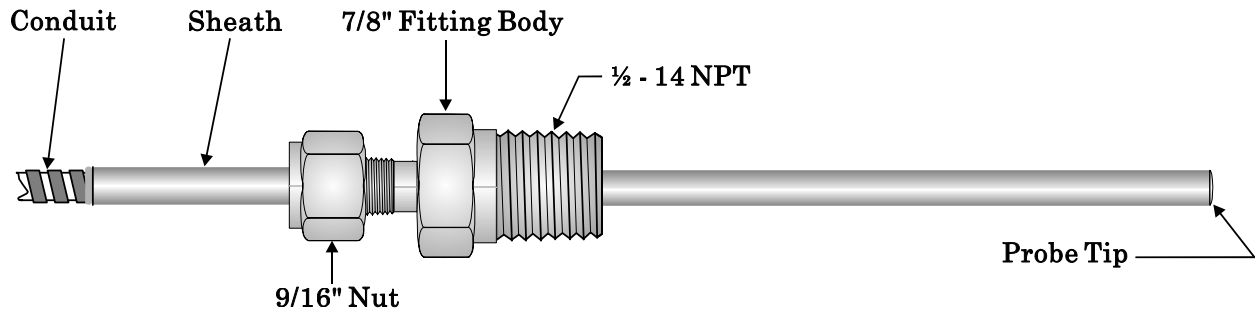
Figure 2-25 - RTD Probe Installation/Removal Diagram

2.3.6 21V Power Supply Option

21V Power Supplies are mainly used in conjunction with Temperature and Pressure Transmitters which require a higher than +12V but lower than +21.4V (±.8V) input supply to operate (such as Series 3508 Transmitters).
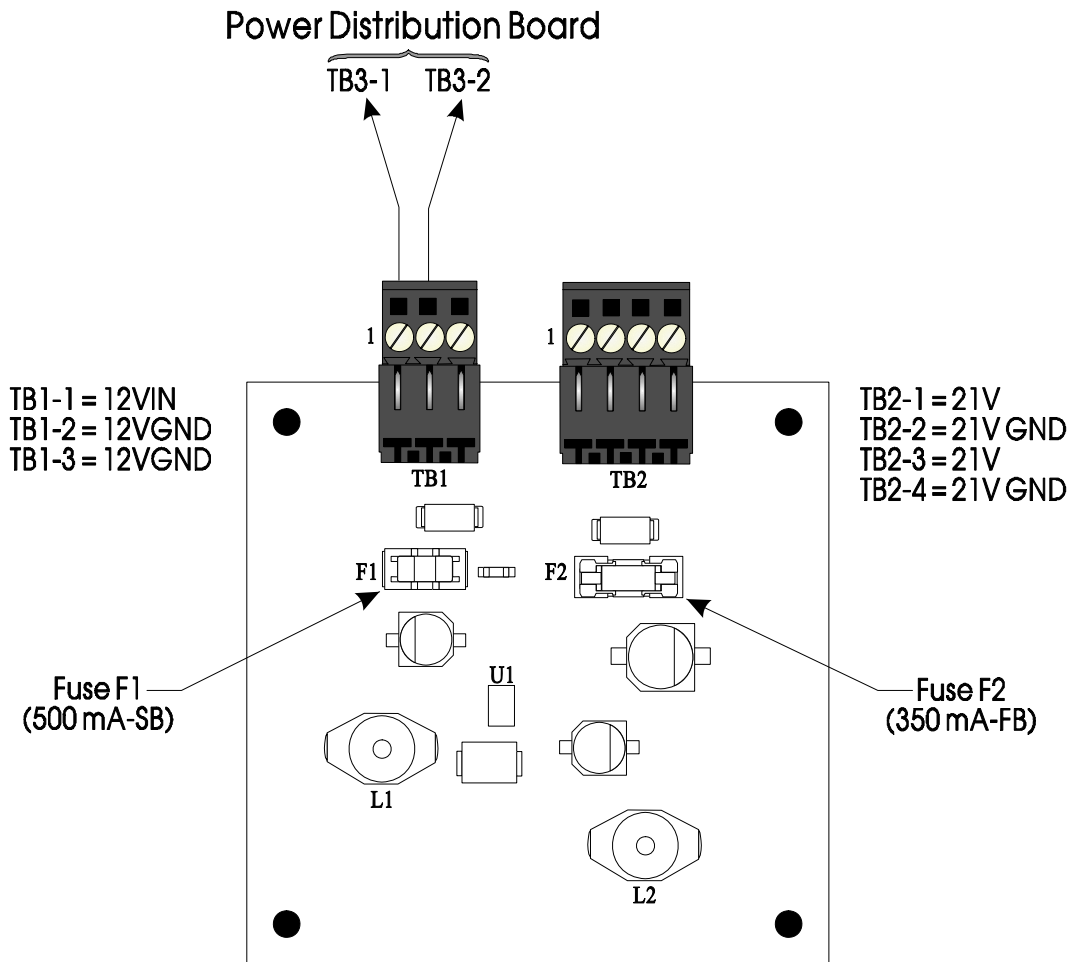
Figure 2-26 - 21V Power Supply Board

21V Power Supply Boards contain two terminal blocks that accommodate power connections between the **Control**Wave **EFM** and remote transmitters. TB1 is a three-position terminal block that provides input power connection from the Power Distribution Board. Four-position Terminal Block (TB2) provides +21V power and ground to external devices such as Series 3508 Transmitters.

<div align="center">**Table 2-13 - 21V Power Supply Board Terminal Designations**</div>

21VPS TB#	21VPS TB NAME	CONNECTION to PDB.	CONNECTION to XMTR.
TB1-1	+12VIN	TB3-1	N/A
TB1-2	12VGND	TB3-2	N/A
TB1-3	CHASSISGND	N/A	N/A
TB2-1	+21V	N/A	XMTR1+
TB2-2	21VGND	N/A	XMTR1-
TB2-3	+21V	N/A	XMTR2+
TB2-4	21VGND	N/A	XMTR2-

2.3.7 Digital to Relay I/O Board Option

Digital to Relay I/O Boards except up to two discrete input signals from an open drain MOSFET device and convert them to Form C relay output signals using Solid State Relay (SSR) logic. The minimum current load will be 100mA. Figure 2-27 provides a component view of the Digital to Relay I/O Board.

Each **Control**Wave **EFM** Discrete Output is converted to a Form C relay output signal which can be configured for opposite or identical state conditions, i.e., both Normally Open (NO) or Normally Closed (NC) or one Normally open with the other Normally Closed.
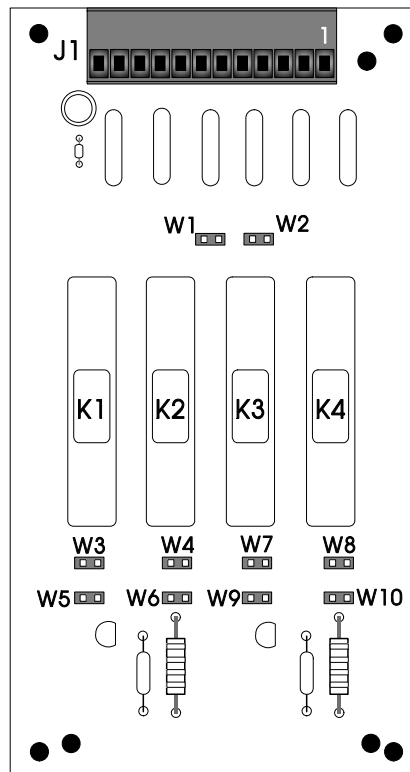
<div align="center">**Figure 2-27 - Digital to Relay I/O Board**</div>

2.3.7.1 Digital to Relay I/O Board Jumper Settings

The Digital To Relay I/O Board contains ten (10) Jumpers which allow the user to configure contacts for Normally Open/Normally Closed states. Contacts associated with each of the Form C Relays may be configured for identical or opposite states. ***Note: Jumper Pairs W3/W5, W4/W6, W7/W9 and W8/W10 must be set in opposite states.***

The commons associated with each form C Relay (R0COM and R1COM) have the option of being tied to the **Control**Wave **EFM** Power Ground or to a floating Ground. Jumper W1 is associated with Outputs R0A and R0B and W2 is associated with outputs R1A and R1B. When Jumper W1 is installed the common (C) associated with Outputs R0A and R0B is tied to **Control**Wave **EFM** Power ground; when Jumper W1 is not installed, the common will be floating. When Jumper W2 is installed the common (C) associated with Outputs R1A and R1B is tied **Control**Wave **EFM** Power ground; when Jumper W2 is not installed, the common will be floating.

Table 2-14 - Jumper Settings versus Form C Relay Output States

JUMPERS W3/W5	R0A STATE	JUMPERS W4/46	R0B STATE	JUMPERS W7/W9	R1A STATE	JUMPERS W7/W9	R1B STATE
IN/OUT	NO	IN/OUT	NO	IN/OUT	NO	IN/OUT	NO
OUT/IN	NC	OUT/IN	NC	OUT/IN	NC	OUT/IN	NC

Table 2-13 provides the relationship between Jumper settings and Form C Relay Outputs.

Table 2-15 - Digital To Relay I/O Board Connections to J1/P1

J1 Pin	Signal	Function	Wiring Connections
1	R1B	Relay 1 Output B	To Field
2	R1A	Relay 1 Output A	To Field
3	R1COM	Relay 1 Common	To Field (See W2)
4	CHASSIS GND	Chassis Ground	CWMICRO Chassis Gnd. Lug
5	R0COM	Relay 0 Common	To Field (See W1 - Section 1.1.1)
6	ROB	Relay 0 Output B	To Field
7	ROA	Relay 0 Output A	To Field
8	-	-	-
9	POWER GND	Power Ground	Pwr. Dist. Bd. TB4 Pin 2 (Black Wire)
10	POWER - DC	Power - 6/12 Vdc	Pwr. Dist. Bd. TB4 Pin 1 (Red Wire)
11	DOUT0	Discrete Output 0	DI/O Module TB2-5 - TB2-8 or Mixed I/O Module TB1-1 - TB1-6 (Yellow Wire)
12	DOUT1	Discrete Output 1	DI/O Module TB2-6 - TB2-8 or Mixed I/O Module TB1-2 - TB1-6 (Orange Wire)

The DI/DO Module and the Mixed I/O Module provide independently firmware controlled open drain outputs, which can be used for control or signaling functions (DI/DO Modules provide up to four DO while the Mixed I/O Module provides up to 6 DO). Each output is wired to the source terminal of an N Channel MOSFET capable of switching up to 16 Volts at up to 100mA. When closed, the FET shorts the output to ground with resistance of .5 Ohms or less. These outputs are protected by 16V Transorbs. Since these outputs are not isolated, caution must be exercised to ensure that the load current does not affect operation of the **Control**Wave **EFM** or related devices.

Two of these outputs may be wired to field circuitry via the Digital to Relay I/O Board option (see Figure 2-28). Table 2-15 provides the wiring connections for the DI/O Module or the Mixed I/O Module and the Digital to Relay I/O Board.
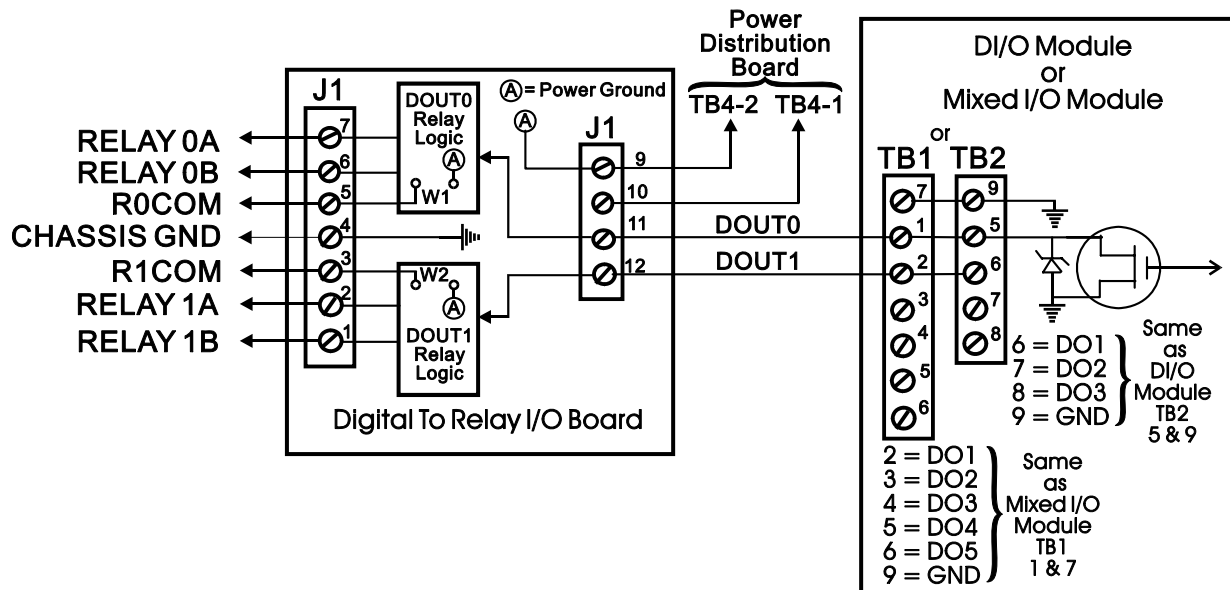
Figure 2-28 - Digital to Relay I/O Board Wiring Diagram

2.3.8 Connection to a Model 3808 Transmitter

A Model 3808 Transmitter (Digital) can be interfaced to a **Control**Wave **EFM** via either an RS-232 or an RS-485 communication scheme. Communication schemes and cable lengths are determined the type of communication port utilized. In general RS-232 communications are utilized when the Model 3808 Transmitter is situated within 25 feet of the **Control**Wave **EFM,** i.e., for local communications. Communications can be achieved with transmitters up to 4000 feet away (remote communications) via the RS-485 scheme.
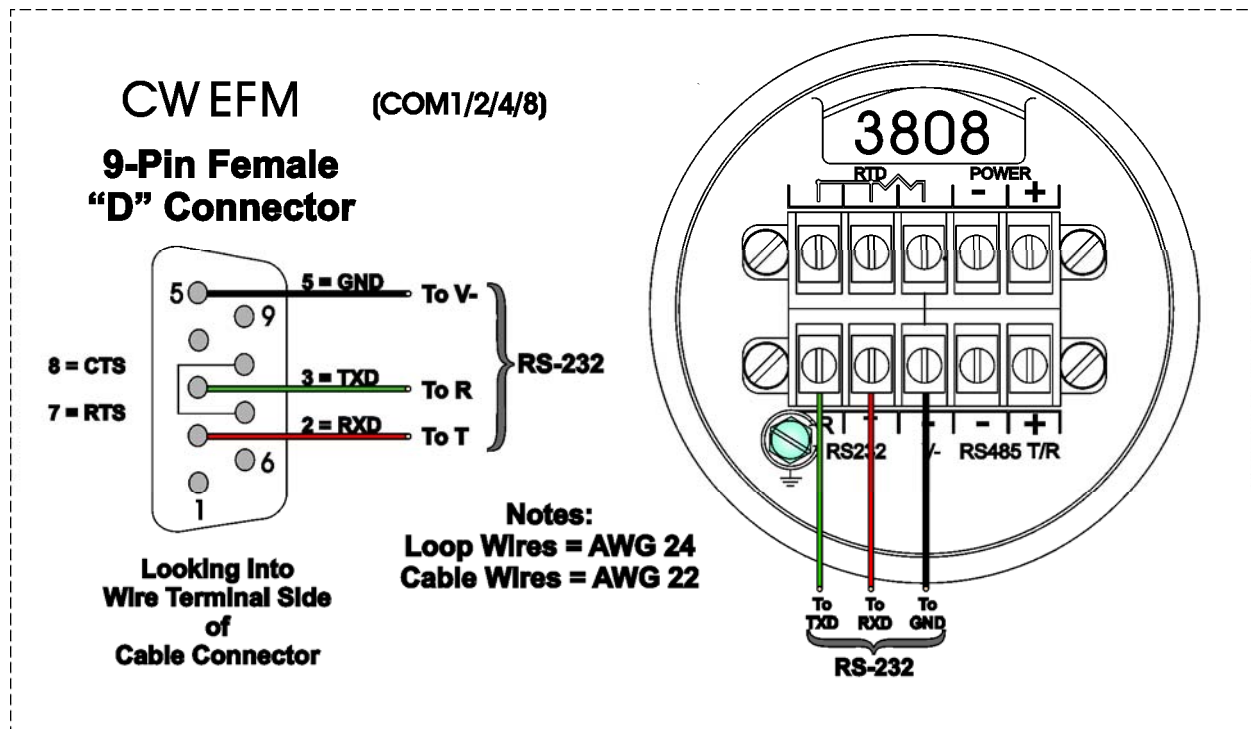
Figure 2-29 - Model 3808 Transmitter to Control Wave **EFM**
RS-232 Comm. Cable
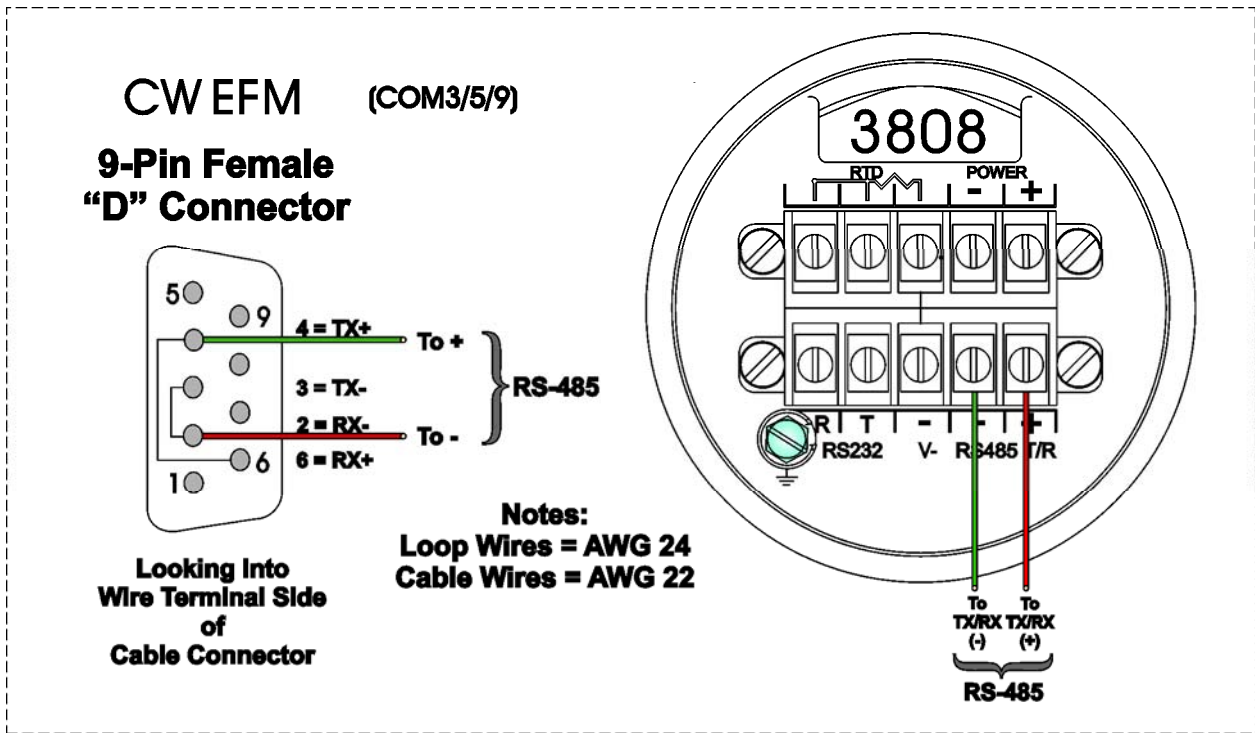
Note: For Loopback & Termination Control:
Use SW3 on CPU Module to configure COM3.
Use SW1 on ECOM Module to configure COM5 or COM9.

Figure 2-30 - Model 3808 Transmitter to ControlWave EFM
RS-485 Comm. Cable
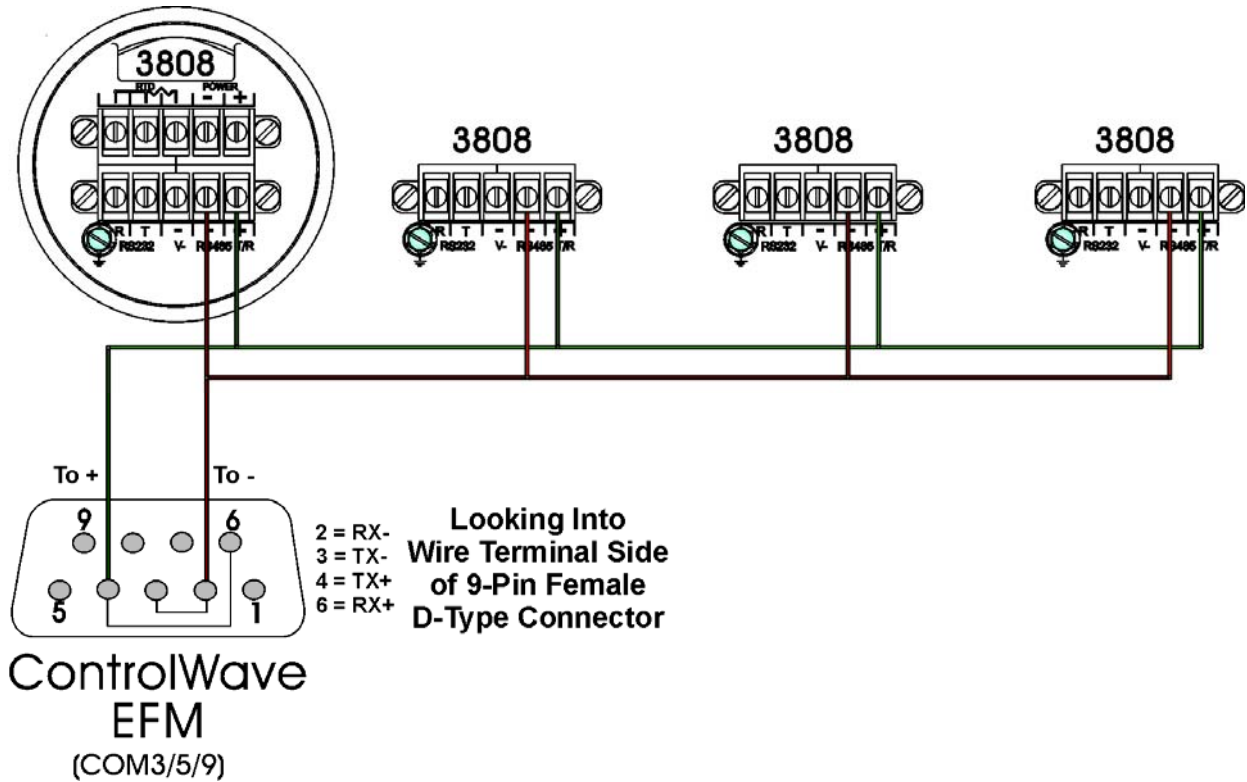
Figure 2-31 - ControlWave EFM to 3808s - RS-485 Network Diagram

Figures 2-29 and 2-30 detail the RS-232 and RS-485 wiring connections required between the **Control**Wave **EFM** and the Model 3808 Transmitter.

Up to eight (8) Model 3808 Transmitters can be connected to a **Control**Wave **EFM** via a half duplex RS-485 Network. An illustration of this network is provided in Figure 2-31.

2.3.9 Power Wiring & Distribution

Power may be provided from a rechargeable 12V lead-acid battery (used in conjunction with a 30W Solar Panel (with a built-in Regulator) or a user supplied external bulk dc power supply (4.5 to 16Vdc). A Power Distribution Board is required if the unit is equipped with an external radio/modem, or 21Vdc Power Supply Board, or Digital to Relay I/O Board (or any combination of them) and bulk power is supplied from an external bulk dc source.
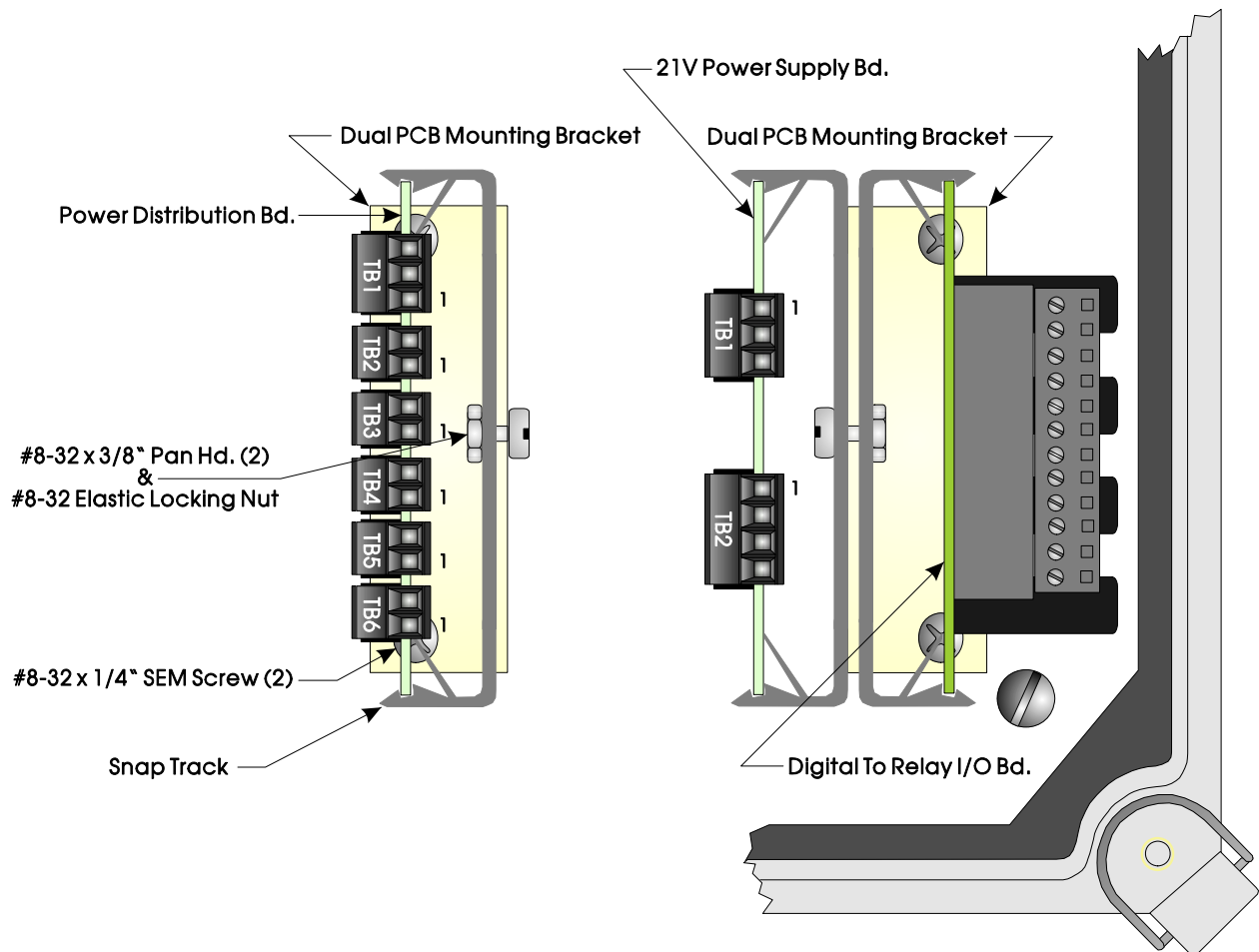
Figure 2-32 - Pwr. Distribution Bd. and Other Options - Snap Track Mounting

ControlWave **EFM** Terminal Blocks utilize compression-type terminals that accommodate up to #14 AWG wire. A connection is made by inserting the wire's bared end (1/4" max) into the clamp adjacent to the screw and then securing the screw. The wire should be inserted fully so that no bare wires are exposed to cause shorts. If using standard wire, tin the bare end with solder to prevent flattening and improve conductivity. Allow some slack in the wires when making connections. The slack makes the connections more manageable and helps to minimize mechanical strain on the terminal blocks.

Power Distribution Boards are provided with six (6) Terminal Connector Blocks that function as follows:

TB1 - Primary Power Input: (three-conductor) (from user supplied bulk power source)
  TB1-1 = Power+ (Pos. input)
  TB1-2 = Power– (Neg. input)
  TB1-3 = Chassis (GND)
TB2 - Main Power Output 1: (two-conductor) (to SCM Power Connector TB1)
  TB2-1 = PWR1+ to TB1-1 on SCM (+VIN)
  TB2-2 = PWR1– to TB1-2 on SCM (–VIN)
TB3 - Main Power Output 2: (two-conductor) (to 21V PS Board Connector TB1)
  TB3-1 = PWR2+ to TB1-1 on 21VPS (+VIN)
  TB3-2 = PWR2– to TB1-2 on 21VPS (GND)
TB4 - Fused Power Output 1: (two-conductor) (to Digital to Relay I/O Board Connector J1)
  TB4-1 = FPWR1+ to J1-10 on D-to-R I/O Bd. (PWR+)
  TB4-2 = FPWR1– to J1-9 on D-to-R I/O Bd. (PWR GND)
TB5 - Fused Power Output 2: (two-conductor) (to External Modem/Radio Pwr. Connector)
  TB5-1 = FPWR2+ to Radio/Modem Power+
  TB5-2 = FPWR2– to Radio/Modem Power– (PWR GND)
TB6 - Fused Power Output 3: (two-conductor) (optional use - similar to TB5)
  TB6-1 = FPWR3+ to Radio/Modem Power+
  TB6-2 = FPWR3– to Radio/Modem Power– (PWR GND)

Note: F1 is rated at 1.5A and protects the Solar Panel Regulator Circuitry. Fuse F3 is rated at .5A and protects Fused Power Output 1. F1 and F3 are provided for Class I, Div. 1 Hazardous Location use Only.
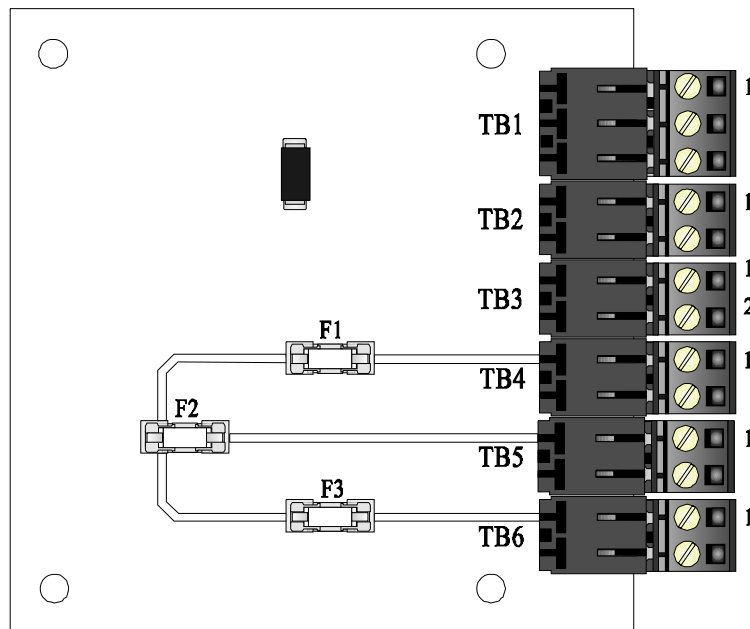
Figure 2-33 - Power Distribution Board

2.3.9.1 Bulk Power Supply Current Requirements

ControlWave **EFM** electronic flow meters are equipped with a System Controller Module that accepts either 6Vdc or 12Vdc Bulk Power input. The maximum current required for a particular **Control**Wave **EFM** can be estimated as follows:

Bulk +6/12Vdc Supply Current = CPU* + Sum of all ECOM Modules, I/O Modules, optional Boards & Optional External Modem/Radio

This summation will accommodate steady state current draw. Table 2-16 provides detailed steady state power current requirements for each **Control**Wave **EFM** Base Assembly module. Note: In the case of an external modem/radio, the unit's manufacturer provides power consumption specifications. Power requirements for the optional Digital to Relay I/O Board, 21V Power Supply Board and the Battery Charger/Power Manager Board are provided in Sections 4.5, 4.6 and 4.7 (respectively) of this manual.

Table 2-16 - Control Wave **EFM Base Assembly Power Requirements**

COMPONENTS	BULK 12Vdc Supply	BULK 6Vdc Supply
CPU* = CPU + SCM + Backplane	8.6mA	14mA
Non-Isolated AI/O Module	2.8mA + (47.2mA - VEXT)	5.6mA + (47.2mA - VEXT)
Non-Isolated DI/O Module	12mA	24mA
Non-Isolated HSC Module	5mA	10mA
Non-Isolated Mixed I/O Module (with optional AO Board)	16.67mA + (24.3mA - VEXT)	34mA + (24.3mA - VEXT)
ECOM Module (without Modem/Radio)	22mA	45mA
ECOM Module (with MultiTech Modem)	56mA	112mA
ECOM Module (with MDS Radio)	277mA	555mA
ECOM Module (with Modem & MDS Radio)	311mA	622mA
ECOM Module (with FreeWave Radio)	272mA	545mA
ECOM Module (with Modem & FreeWave Radio)	306mA	612mA

Note: Current consumption provided in Table 2-15 is based on the standard Electronic Flow Computer application load.

2.3.9.2 Power Wiring

DC Power is interconnected to the System Controller Module (SCM) on Connector TB1. One Bulk DC supply can be connected to the **Control**Wave **EFM** SCM. The Bulk DC supply (nominally +6Vdc or +12Vdc) connected to TB1-1 (+VIN on SCM) is converted, regulated and filtered by the SCM to produce +3.3Vdc. This SCM circuit is fused at 1A. The operating range of the SCM is +4.5/4.9Vdc to +16.0Vdc (nominal +6Vdc input source) or +9.6/10.3Vdc to +16.0Vdc (nominal +12Vdc input source).

SCM Connector TB1 provides 3 input connections for bulk power as follows:

TB1-1 = (+VIN) (+4.5/4.9V to +16V dc for +6V bulk) (+9.6/10.3V to +16V dc for +12V bulk)
TB1-2 = (-VIN) (Supply Ground)
TB1-3 = Chassis Ground - CHASSIS
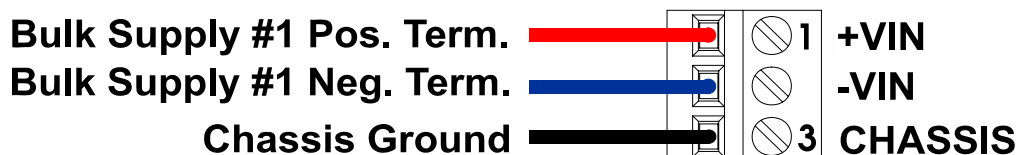
Figure 2-34 - SCM (TB1) Typical Wiring Scheme

2.3.9.3 Mounting an Optional Solar Panel

Solar Panels (used to charge the rechargeable lead acid batteries) are to be mounted to a 2"
to 2-3/8" pipe as illustrated in Figure 2-35. Muffler (Pipe) Clamps, utilized for this purpose,
are secured via four 1/4-20 nuts and washers.

Note 2: Item D slots accommodate Tilt Angle Adjustment.

**NOTE 1: To Attach item C to item D:
Slide two bolts (A) through the top and bottom
Solar Panel (Centered) Channel Holes. Affix item
C to item D via 2 sets of item A hardware as
follows: Flat Washer, Lock Washer & Hex Nut
(Max. Torque = 120 Inch-Pounds).**

Adjustable Tilt Angle

Vertical Pole

**A - 6 places consists of
the following hardware:**
5/16-18 x .75 Hex Hd. Bolt
5/16 Flat Washer
5/16 Spring Lock Washer
5/16-18 Hex Nut

B - 2 places:
2-3/8 U-Clamp Assembly

**C - Adjustable Angle Bracket
(Attaches to Solar Panel)**
D - Pole Mounting Bracket
E - 30 or 40 Watt Solar Panel

Figure 2-35 - 30/40 Watt Solar Panel Mounting Diagram

2.3.9.3.1 Swivel (Directional Facing)

Solar Panels used in the Northern Hemisphere should face due south (not magnetic south)
while those used in the southern hemisphere should face due north (not magnetic north).

2.3.9.3.2 Tilt Angle

30/40 Watt Solar Panel Systems (see Figure 2-35) have adjustable tilt angles. Table 2-17 shows the angle (from horizontal) at which the Solar Panel should be installed in order to maximize annual energy output. At most latitudes, performance can be improved by less of an angle during the summer and more of an angle during the winter.

Table 2-17 - Solar Panel Tilt Angle for 40 Watt & 30 Watt Solar Panels

LATITUDE	INSTALLATION ANGLE
0-4°	10° from Horizontal
5-20°	Add 5° to the Local Latitude
21-45°	Add 10° to the Local Latitude
46-65°	Add 15° to the Local Latitude
66-75°	80° from Horizontal

2.3.9.4 Installing the Rechargeable Battery and Solar Panel Harness

The Rechargeable Sealed Lead-acid Battery must be removed from its shipping carton and installed on its mounting bracket within the enclosure as illustrated in Figure 2-36.

1 = Battery Mounting Bracket
2 = Battery Mounting Bracket (Screws)(Qty. 6)
3 = Battery Clamp
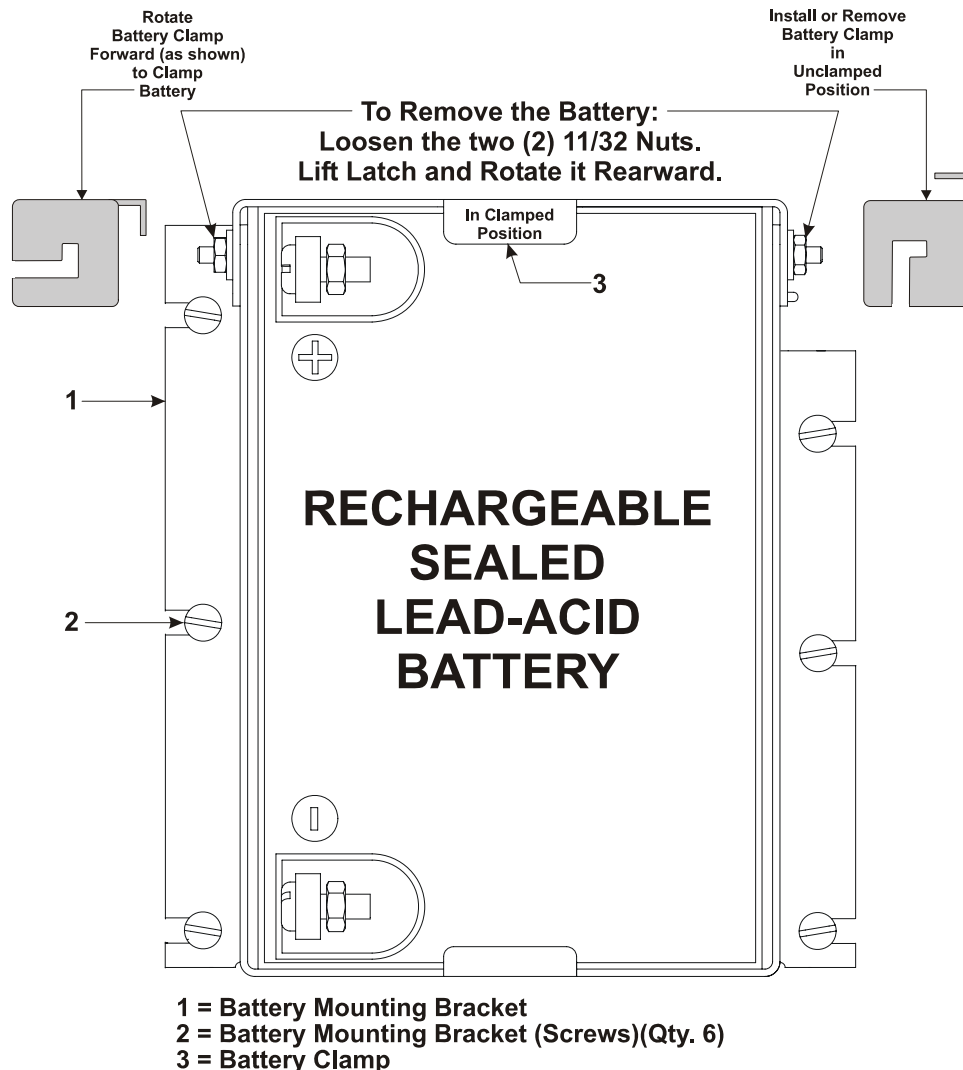
Figure 2-36 - Enclosure with Sealed Lead-acid Battery Installed

1. Remove connector TB1 from the System Control Module (SCM) and remove the Battery/Power Harness from the Battery Charger/Power Manager Board.
2. Remove the Lead-acid Battery from its shipping carton.
3. Install the Lead-acid Battery (on end) as illustrated in Figure 2-36. **Note: Make sure the Lead-acid Battery is fully charged before installing it.**
4. Route Solar Panel Power Wiring Harness into the enclosure through the Solar Power Conduit Fitting (see Item 5 of Figure 2-3).
5. Connect the Solar Panel Harness to the internal Battery (Red = Pos. & Black = Neg.).
6. Secure the Battery via the Battery Clamp.
7. When you are ready to apply power, connect the Battery Power Harness to either the Power Distribution Board (if present) or to TB1 on the SCM.

2.3.9.5 ControlWave EFM System Grounding

ControlWave **EFM** Enclosures are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Enclosure's Ground Lug (see Figure 2-3) and a known good Earth Ground. As an extra added precaution, it is recommended that a #14 AWG wire be run from SCM Power Connector TB1-3 (Chassis Ground) to the same known good Earth Ground. The following considerations are provided for the installation of **Control**Wave **EFM** system grounds (see S1400CW):

- Chassis Ground Lug to Earth Ground wire size should be #4 AWG. It is recommended that stranded copper wire is used and that the length should be as short as possible.
- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).
- The wire ends should be tinned with solder prior to insertion into the Chassis Ground Lug. *Note: Use a high wattage Soldering Iron.*
- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground.

2.3.10 Operation of the Lithium Backup Coin-cell Battery

CPU Modules have a Coin-cell Socket (S1) that accommodates a 3.0V, 300 mA-hr lithium coin cell. A supervisory circuit on the CPU is used to switch to battery power when the regulated 3.3Vdc VCC falls out of specification. The CPU switches the battery voltage to the VBAT3.3 hardware signal, which provides backup power for the real-time clock (RTC) and the system SRAM on the CPU Module.

The system SRAM has a standby current draw of 20uA maximum for each part. For a unit containing 2MB of SRAM, a worst-case current draw of 42uA allows a battery life of approximately 7142 hours.

Jumper JP1 on the Battery Backup Board must be installed to enable the battery. For maximum shelf life, the battery may be isolated from the circuit by removing Jumper JP1. JP1's suitcase jumper can be stored on either of its pins.

CPU Modules are shipped with the Lithium backup battery installed. To remove the backup battery, pry up the Battery Securing Tab on the Coin-cell Battery Socket and then remove the battery using a pair of tweezers or needle-nose pliers. Install the replacement battery. Note: This step will not be required until units have been in operation for an extended period of time (normally many years) as the battery life is approximately 7142 hours of backup service. (Power is drawn from the battery when the unit looses power).

NOTE:

If the Battery or is removed when power is off the contents of SRAM (on the CPU Module) will not be retained. Once a Battery has been removed, don't install a replacement Battery for at least one minute unless SW2-5 on the CPU has been set OFF.

2.3.11 Installation of a Bezel Assembly (see Figure 2-2 & 2-37)

Bezel Assemblies provide a protective cover and wire routing for any two **Control**Wave **EFM** I/O Modules. One Bezel Assembly will cover Slots 3 & 4 (when equipped with I/O Modules) and will provide the following functions:

- It can be removed to access the two I/O Modules.
- Bundled wires and cables are routed downward between the Modules and the Bezel.
- The Bezel is functional and its appearance is contiguous with the I/O Modules.

Bezel Assemblies are provided when two I/O Modules are ordered and should be installed whenever the unit is operational (except during service). The Bezel is secured to the Covers of two I/O Modules via four built-in latches (hooks). To remove the Bezel assembly, gently grasp its sides and pull up and then away from the Chassis.

Installation of the Bezel Assembly requires that its latches be aligned with their mating notches on the associated left and right I/O Module Covers. Once the Bezel has been properly aligned with the notches on the I/O Module Covers, simply press in and then downward to set it into place.
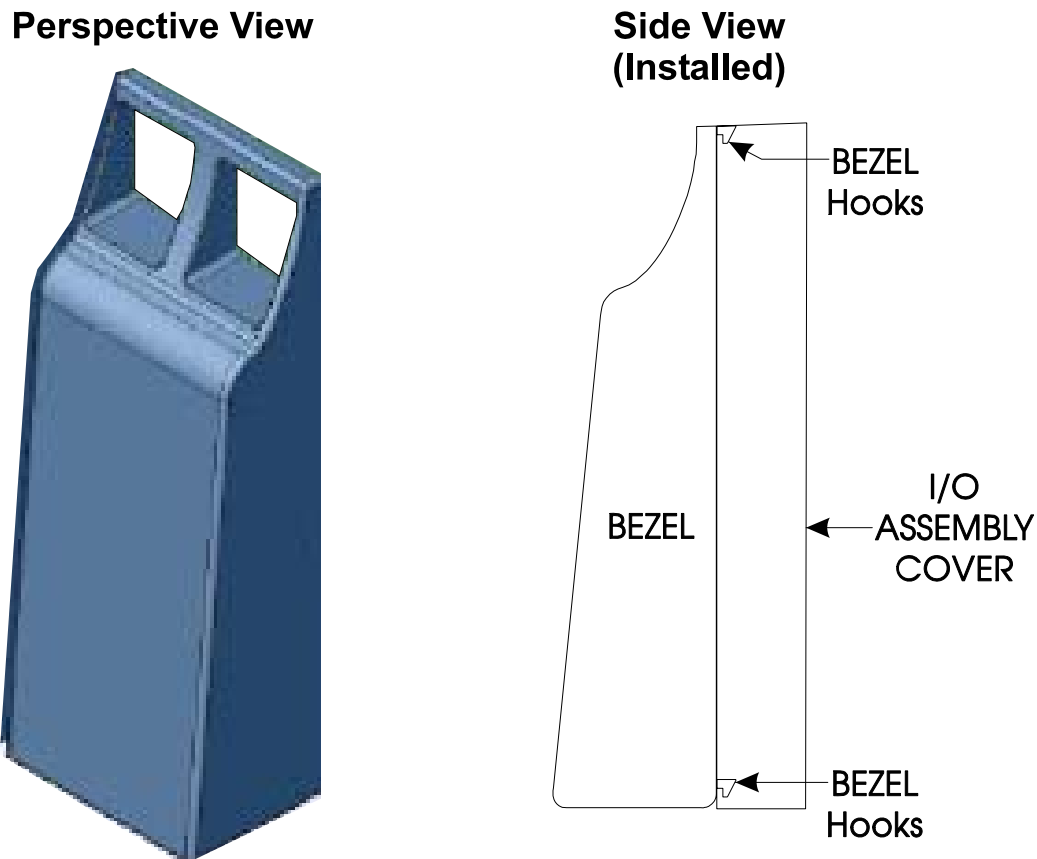
Figure 2-37 - Bezel Assembly

2.4 OPERATIONAL DETAILS

ControlWave **EFM** electronic flow computers are shipped from the factory with firmware that allows the unit to be configured in conjunction with an IEC 61131, application program. This section provides information as follows:

- Steps required to download the application load and place the unit into 'Run' mode.
- Steps required to download system firmware.
- Operation of the SCM Module's Mode Switch
- Soft Switch Configurations and Communication Ports

Operational details on **Control**Wave **EFM** LEDs, the SCM's Status LEDs and use of the BBI WINDIAG program for fault isolation are provided in Chapter 3.

2.4.1 Downloading the Application Load

Any **Control**Wave **EFM** must have a configured application load before it can be placed into operation. For units not shipped with the 'Standard Load,' this will require connection of the **Control**Wave **EFM** to a PC running Windows NT (4.0 or higher), Windows 2000 or Windows XP Professional and equipped with **Control**Wave Designer software & OpenBSI software. Configuration of the application load must be performed by an individual familiar with the various programming tools. The following software user documentation is referenced:

Getting Started with **Control**Wave Designer Manual - D5085
ControlWave Designer Reference Manual - D5088
Open BSI Utilities Manual - D5081
Web_BSI Manual - D5087

An application load download can be initiated, i.e., from **Control**Wave Designer, or from the OpenBSI 1131 Downloader for **Control**Wave **EFM** Nodes.

1. Make sure that the System Controller Module's Mode Switch (SW1) is set in 'Local Mode,' i.e., SW1-1 set to the **OPEN** (Right) position and SW1-2 set to the **CLOSED** (Left) position.

    Note: **From the factory, COM1 defaults to 115.2 Kbaud (RS-232) using the Internet Point to Point Protocol (PPP). Don't connect COM1 to a PC unless the PC's RS-232 port in question has been configured for PPP.**

2. Once the **Control**Wave **EFM** project has been defined, communications and configuration parameters have been set, perform the download according to either '**Control**Wave Designer' (see D5088 - chapter 11) or 'The Open BSI 1131 Downloader' (see D5081 - Chapter 7).

3. After the download has been completed leave the System Controller Module's Mode Switch (SW1) in the 'Local Mode' position.

2.4.2 Upgrading **Control**Wave **EFM** Firmware

The **Control**Wave **EFM** CPU ships from the factory with system firmware already installed. If an upgrade of the system firmware is required, use one of the procedures below to download the new or replacement firmware from the PC.

Upgrade of system firmware via LocalView FLASH Mode requires OpenBSI 5.1 (or newer). If you have an older version of OpenBSI, FLASH upgrades are to be performed via HyperTerminal. You will need a binary (*.BIN) system firmware file, and that file should be defined in the Flash Master File (FLASH.MST). A sample Flash Master File is shown, below:

cwe0420.bin   where cwe is the product code and 0420 is the release #

Upgrade of an unattended **Control**Wave **EFM** can be accomplished from a remote PC. This capability is introduced in Section 2.4.2.3.

2.4.2.1 Using LocalView to Upgrade ControlWave EFM Firmware

NOTE
Your Control Wave **EFM must be set to Recovery Mode ENABLE (ON) prior to performing the FLASH upgrade, then set to Recovery Mode DISABLE (OFF) after the upgrade. On Control**Wave **EFMs this is accomplished via the System Controller's Mode Switch SW1. Set both switches to the OPEN (Right) or CLOSED (Left) positions for Recovery Mode. After setting the System Controller's Switch SW1 for Recovery Mode, turn power OFF and then ON again.**

A null modem cable (see Figure 2-12) must be connected to COM1 of the **Control**Wave **EFM** and to any RS-232 port on the associated PC. The PC's RS-232 port used for this purpose must be set to run at 115.2 Kbaud. **Control**Wave **EFM** CPU Switch SW1, position, 3 must be set ON.

Start LocalView, Choose FLASH, Enter A Name, Click on [Create]

Start LocalView by clicking on: **Start → Programs → OpenBSI Tools → LocalView**. The New View Mode dialog box will appear:
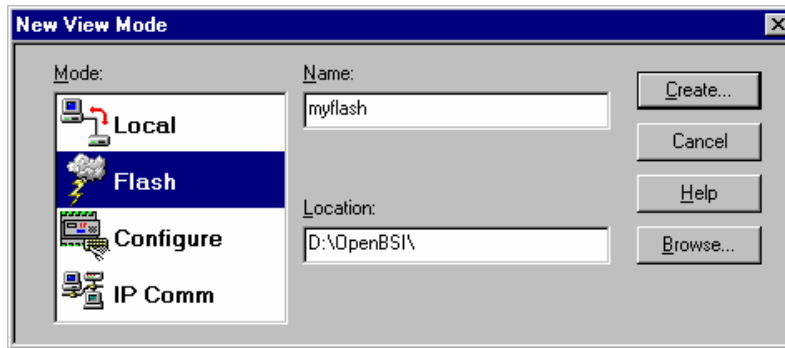
Figure 2-38 - Local View - New View Mode Menu

"Mode"
    Choose 'Flash' for the mode.

"Name"
    Enter a name for the View Mode File in the **"Name"** field.

"Location"
    If you want to store the View Mode File in a directory other than that shown in the **"Location"** field, enter the new location there, or use the **[Browse]** push button to find the directory.

When the **"Mode"**, **"Name"**, and **"Location"** have been specified, click on the **[Create]** push button to activate the Communication Setup Wizard.

Step 1 - Communication Setup

Choose the communication port you want in the **What port would you like to use:** field. Click on the **[Next]** pushbutton to activate the next wizard.
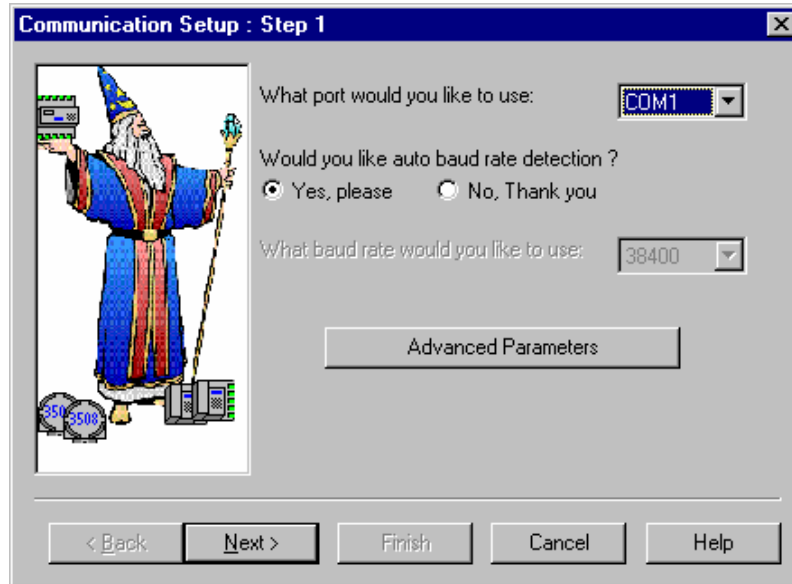
Figure 2-39 - Communication Setup: Step 1 Menu

Step 2 - Flash RTU Setup

In the Flash RTU Setup Wizard, you need not set the RTU type or local address, since these are unused in this mode. Click on the [Next] push button to activate the Flash Data Setup Wizard.
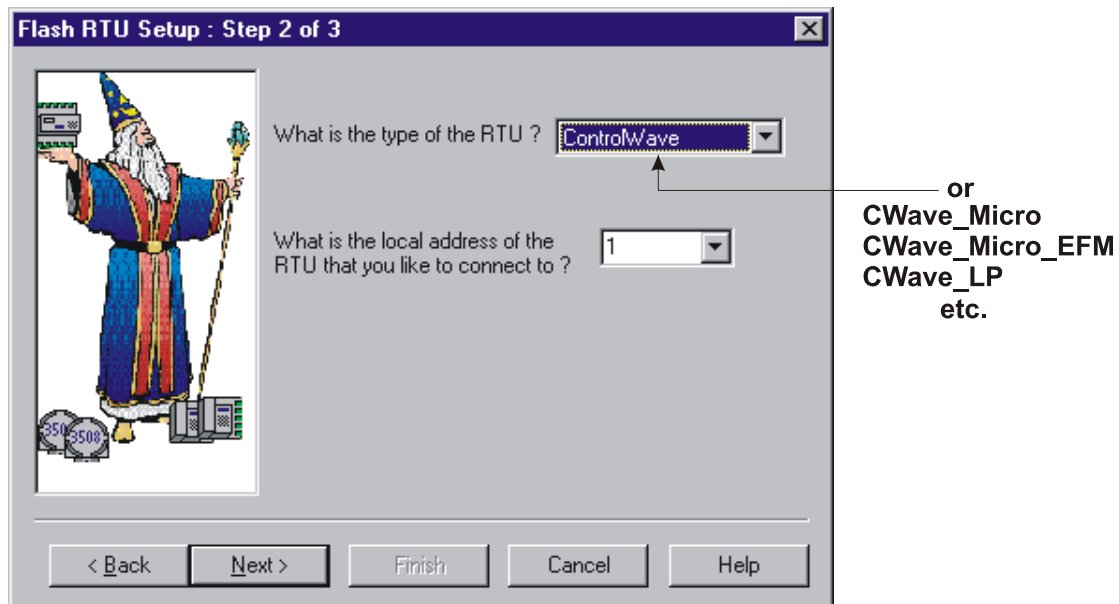
Figure 2-40 - Flash RTU Setup Menu

Step 3 - Flash Data Setup

Complete the following fields in the Flash Data Setup Wizard:

"Please enter the name of the binary file to Flash"
   To upgrade system firmware, you must specify the path and name of a binary (*.BIN) file
   on your hard disk containing the firmware.

Click on **[Finish]** to install the specified BIN file in FLASH memory at the RTU.
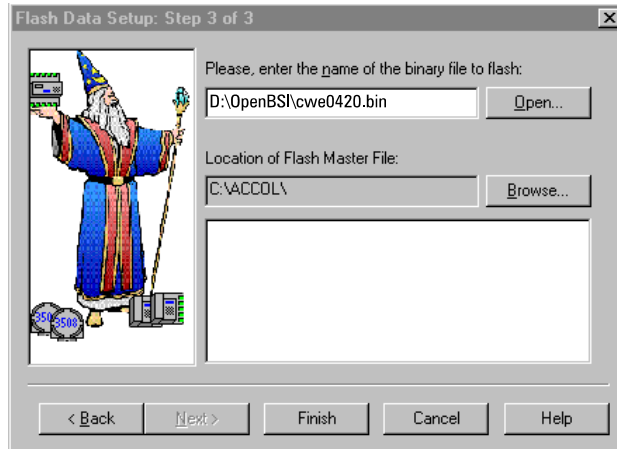
Figure 2-41 - Flash Data Setup Menu
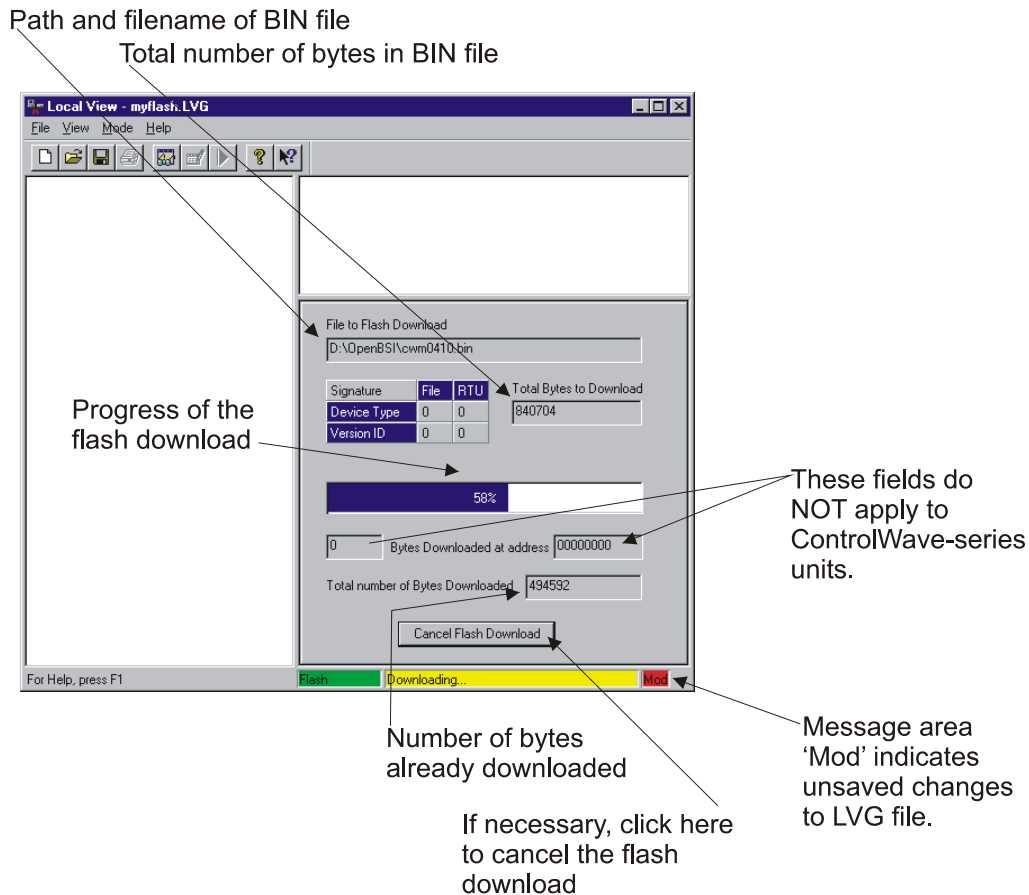
Figure 2-42 - Local View Downloading System Firmware Menu

Once the Flash download has begun, you will NOT be allowed to shut down LocalView, unless you cancel the download, or it has been completed.

The progress of the Flash download will be displayed in the window. Any mismatch in file versions, or if the type of .BIN file does not match the type of RTU, the download will be aborted.

Once the download has completed, disable Recovery Mode by setting System Controller Module switch SW1 as follows: SW1-1 set **OPEN** (**Right**) and SW1-2 set **CLOSED** (**Left**).Switch Power OFF and then ON again.

2.4.2.2 Using HyperTerminal to Upgrade ControlWave EFM Firmware

A null modem cable (see Figure 2-12) must be connected to COM1 of the **Control**Wave **EFM** and to any RS-232 port on the associated PC. The PC's RS-232 port used for this purpose must be set to run at 115.2 Kbaud. **Control**Wave **EFM** CPU Switch SW1, position, 3 must be set to the **ON** position or the System Controller Module Mode Switch SW1 must initially be set as follows: SW1-1 set **OPEN** (**Right**) and SW1-2 set to **CLOSED** (**Left**).

1. If not already running, apply power to the associated PC.

2. Start the HyperTerminal program on the PC. Note: HyperTerminal is a Windows 95 (or newer) application utility program. If using HyperTerminal for the first time, set the communications properties (for the PC Port being utilized) via the Properties Menu as follows: Bits per second: = 115200, Data bits: = 8, Parity: = None, Stop bits: = 1, and Flow control: = None and then click OK.

3. Set the System Controller Module's Mode Switch (SW1) for 'Recovery Mode,' i.e., both switches in the **OPEN** (**Right**) or **CLOSED** (**Left**).position or set CPU Module Switch SW1-3 ON.

4. Apply power to the **Control**Wave. The resident BIOS will initialize and test the hardware, this process is referred to as POST (Power On Self Test).

    Unless there is a problem status code 10 (LED #5 ON) will be posted to the SCM's Status LEDs. Detection of a fault during POST will be posted on the Status LEDs. When the Power On Self Test has completed, a system status code will be posted to the SCM's Status LEDs (see Table 2-18 and Figure 2-47).

    From the HyperTerminal Recovery Mode menu (Figure 2-43), press the 'F' key to enter FLASH download. A message will be displayed warning that the FLASH is about to be erased; press the 'Y' key at the prompt. The screen will display dots as the flash devices are being erased; this could take a few minutes.

5. When the FLASH is ready for download the letter C will be displayed on the screen. In the HyperTerminal command bar click on Transfer and then Send File…(see Figure 2-44). In the Send File Dialog Box (see Figure 2-45), select "1KXmodem" for the protocol, enter the filename of the appropriate .bin file in the format "CWE*xxxxx*.bin" (where *xxxxx* varies from release to release). Click on the Send button to start the download (see Figure 2-45). When the HyperTerminal Recovery Mode Menu of Figure 2-43 appears, the download has completed.

6. Close the HyperTerminal program. The null modem cable connected between the **Control**Wave **EFM** and the PC can be removed if desired.

7. Set the System Controller Module's Mode Switch (SW1) for 'Local Mode,' i.e., SW1-1 in the **OPEN** (**Right**) position and SW1-2 in the **CLOSED** (**Left**) position. Switch Power OFF and then ON again. If CPU Module Switch SW1 was set for Recovery Mode, set SW1-3 OFF.
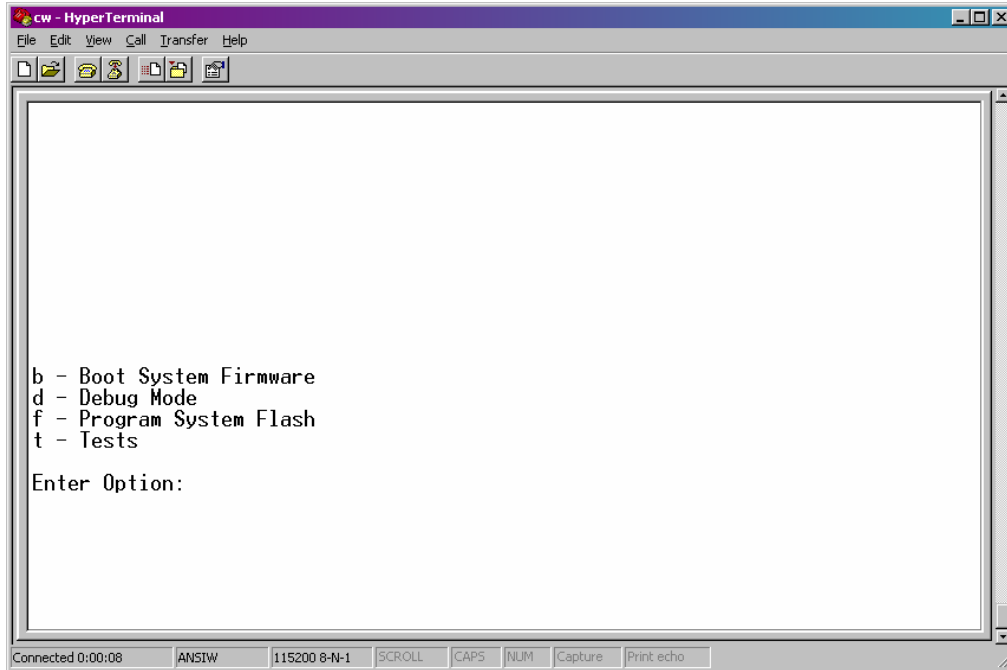
Figure 2-43 - HyperTerminal Recovery Mode Menu
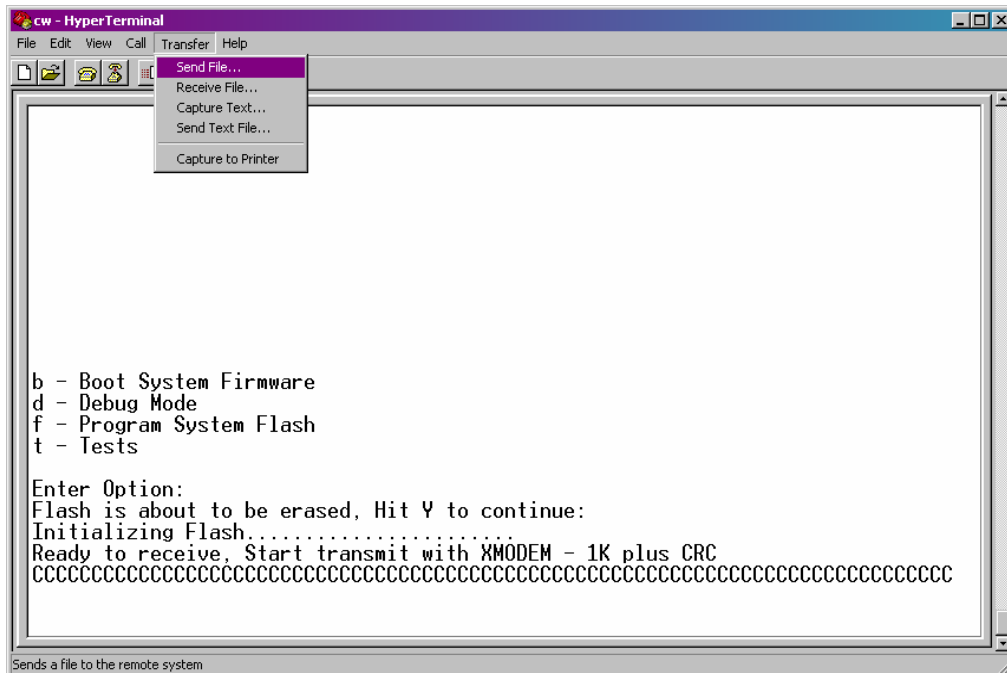
Figure 2-44 - HyperTerminal FLASH Download Menu
(Ready to Download) - (Transfer/Send File Selected)

Once the **Control**Wave **EFM** running its application load, status codes are posted to the six Status LEDs on the PSSM. These Status LED (Hex) Codes are listed in Table 2-15 (see Figure 2-47.
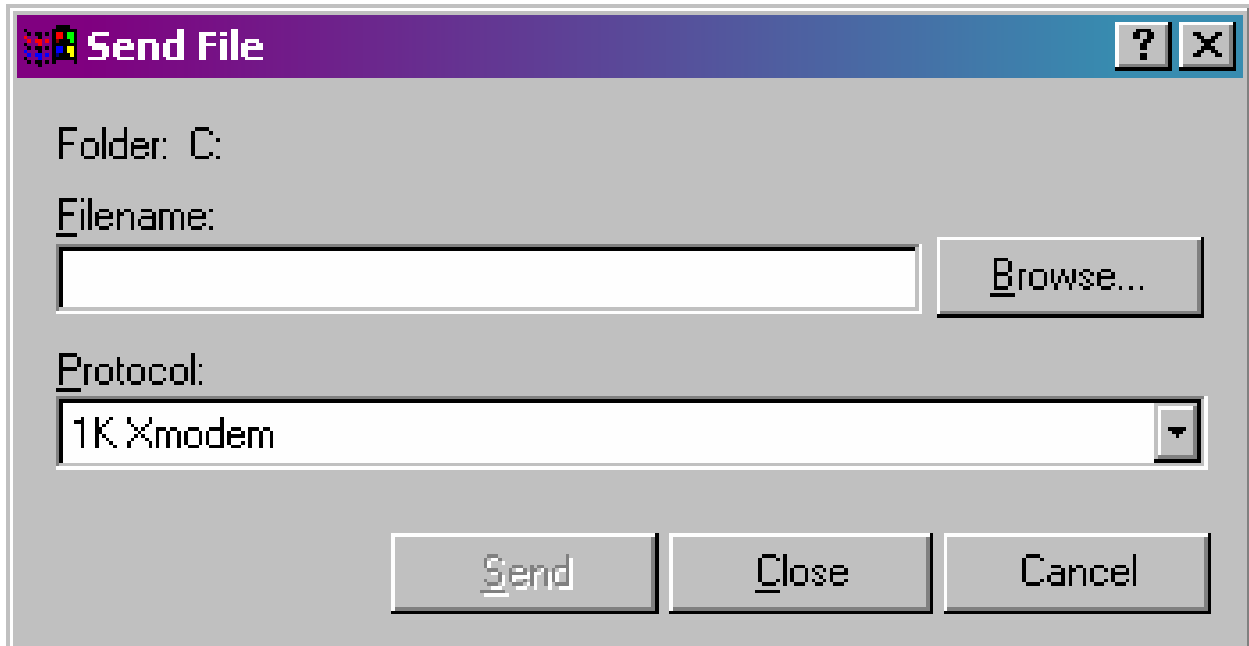
Figure 2-45 - HyperTerminal Flash Download
(Send File Dialog Box - Enter Filename)
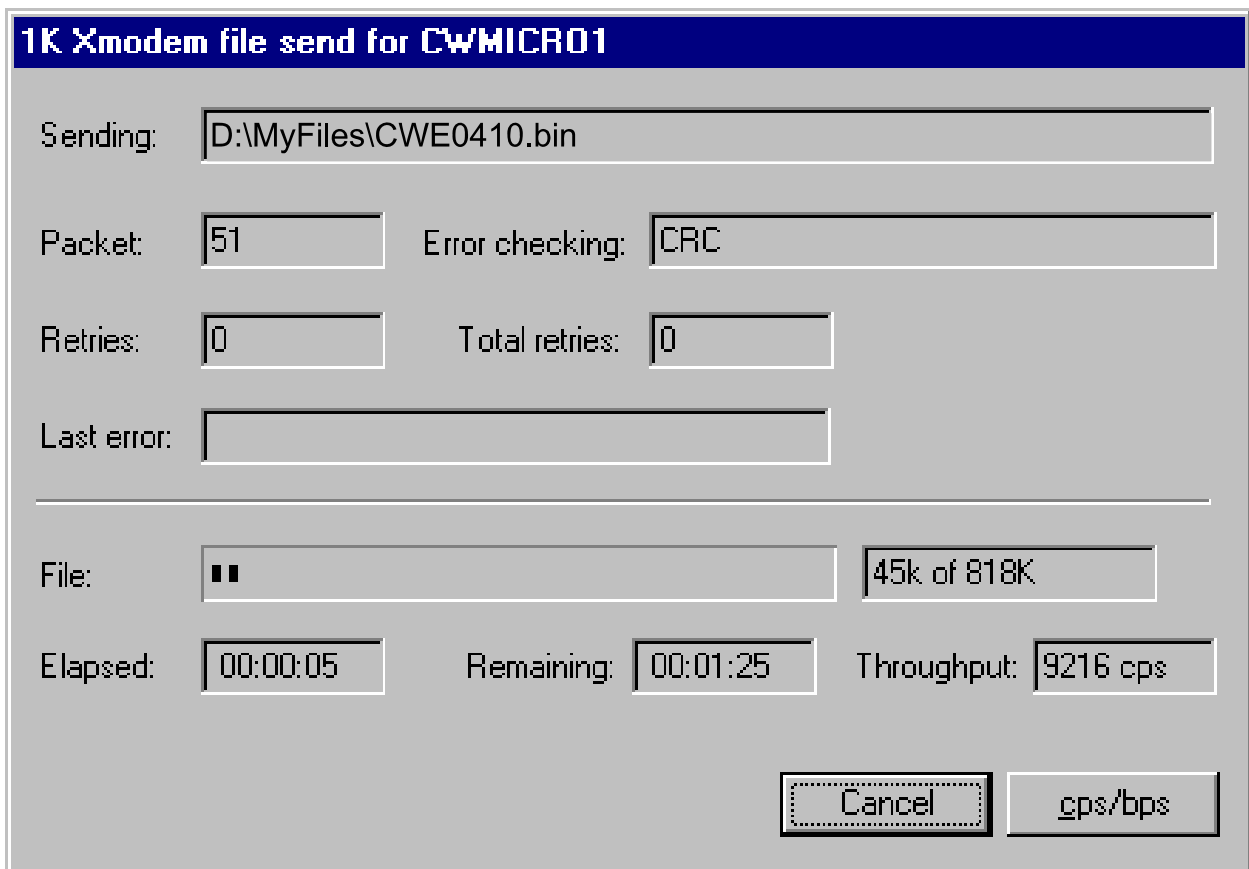
Figure 2-46 - HyperTerminal FLASH Download (Download in Process)

Table 2-18 - System Status LED Codes on System Controller Module

Status In Hex	LED 6	LED 5	LED 4	LED 3	LED 2	LED 1	Indication Definition
00	0	0	0	0	0	0	Application Running
01	0	0	0	0	0	1	Unit in Diagnostic Mode
03	0	0	0	0	1	1	Unit Running Diagnostics
04	0	0	0	1	0	0	Flash XSUM Error
05	0	0	0	1	0	1	Error Initializing Application Device
07	0	0	0	1	1	1	Flash Programming Error
08	0	0	1	0	0	0	Using Factory Defaults (flashed at start)
09	0	0	1	0	0	1	Battery Failure Detected (flashed at startup)
0A	0	0	1	0	1	0	Currently Loading the Boot Project
0B	0	0	1	0	1	1	System Initialization in Progress
10	0	1	0	0	0	0	Waiting in Recovery Mode
11	0	1	0	0	0	1	Error Testing SDRAM
12	0	1	0	0	1	0	Error Testing SRAM
20	1	0	0	0	0	0	Application Loaded
28	1	0	1	0	0	0	Stopped at a Break Point
30	1	1	0	0	0	0	No Application Loaded
38	1	1	1	0	0	0	Running with Break Points
3B	1	1	1	0	1	1	Waiting for Power-down (after NMI)
3E	1	1	1	1	1	0	Waiting for Updump to be Performed
3F	1	1	1	1	1	1	Unit Crashed (Watchdog Disabled)

Figure 2-47 - SCM Status LED Hexi-decimal Codes
(See Table 2-18 for Definitions)

2.4.2.3 Remote Upgrade of ControlWave EFM Firmware

It is possible to download system firmware into an unattended remote **Control**Wave **EFM**. This function can only be accomplished if CPU Board Switch SW2-6 (associated with the unit in question) is set in the ON position (factory default). The procedure for performing a remote download of system firmware is discussed in Appendix J of the Open BSI Utilities Manual (document D5081). **Note: Remote Upgrade of Control**Wave **EFM Firmware requires Boot PROM version 4.7 or higher and System PROM version 4.7 or higher.**

2.4.3 Operation of the Mode Switch

The System Controller's Mode Switch (SW1) is a two position piano type DIP-Switch that functions as follows:

Both switches set to the **OPEN** (**Right**) or **CLOSED** (**Left**) positions = Recovery Mode. Recovery Mode is used for either a firmware upgrade (see Section 2.4.2) or a core updump (see Section 3.6).

SW1-1 set to the **OPEN** (**Right**) position and SW1-2 set to the **CLOSED** (**Left**) position = Local Mode. Local Mode should be selected for normal running operations.

2.4.4 Soft Switch Configuration and Communication Ports

Firmware defined soft switches that control many default settings for various system operating parameters such as BSAP Local Address, EBSAP Group Number, four (4) communication port parameters, etc., can be viewed and, if desired, changed via 'Configuration Web Pages' in Microsoft Internet Explorer via the Flash Configuration Utility. When connecting the **Control**Wave **EFM** to the PC (local or network) for the first time you should be aware of the communication port default parameter settings provided below (see Figures 2-8 through 2-13B). *Note: Communication port factory defaults can be enabled anytime by setting CPU Board Switch SW2-3 to the OFF position.*

COM1: From the factory, RS-232 Communications Port COM1 defaults to 115.2 kbd (RS-232) using the Internet Point to Point Protocol (PPP). *Note: By setting CPU Switch SW2-8 OFF, the boot project will be prevented from running and the unit will be placed into diagnostic mode.* To test COM1 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* Connection to a PC requires the use of an RS-232 "Null Modem" cable (see Figure 2-12).

COM2: From the factory, RS-232 Communications Port COM2 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM2 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.*

COM3: RS-485 Communications Port COM3 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM3 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-4A & 2-5) can be connected between COM3 and the PC's RS-485 Port.

COM4: From the factory, RS-232 Communications Port COM4 on the first optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM4 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* When required, an RS-232 "Null Modem" cable be connected between COM4 and the PC (typically COM1) (see Figure 2-12).

COM5: RS-485 Communications Port COM5 on the first optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/ControlWave Designer protocol operation. To test COM5 using the

WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-4A & 2-5) can be connected between COM5 and the PC's RS-485 Port.

COM8: From the factory, RS-232 Communications Port COM8 on the second optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM8 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* When required, an RS-232 "Null Modem" cable be connected between COM8 and the PC (typically COM1) (see Figure 2-12).

COM9 RS-485 Communications Port COM9 on the second optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM9 using the WINDIAG program, it must not otherwise be in use. *Note: CPU Switch SW2-8 must be set OFF to run the WINDIAG program.* In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-4A & 2-5) can be connected between COM9 and the PC's RS-485 Port.

2.4.5 Optional Display/Keypad Assemblies

Two Display/Keypad Assemblies are offered; one with a dual-button Keypad (see Figure 2-48) and one with a 25-button Keypad (see Figure 2-49). Both Display/Keypad Assemblies utilize identical 4 x 20 LCD Displays. Each Display/Keypad Assembly employs a unique microcontroller based Display/Keypad Interface Assembly that drive the 4 x 20 LCD Display and interfaces the Keypad. Interface to the **Control**Wave **EFM** is made via a cable equipped with RJ-45 plugs. This cable connects to the RJ-45 Display Interface Jack (J2) on the System Controller Module and the RJ-45 Jack (J1) on the Display/Keypad Assembly. A potentiometer is provided on the Display/Keypad Sub-assembly to set the contrast of the LCD Display.

Figure 2-48 provides mounting hardware information for the Dual-button Display/Keypad Assembly. Operation of the Dual-button Display/Keypad Assembly is discussed in section 2.4.5.1.

Figure 2-49 provides mounting hardware information for the 25-button Display/Keypad Assembly. Information on configuring the 'Display Function Block' (required to configure the Display associated with the 25-button Display/Keypad Assembly) is provided in ControlWave Designer's On-Line Help.

Note: Operation of the 25-button Display/Keypad Assembly is discussed in Appendix E.
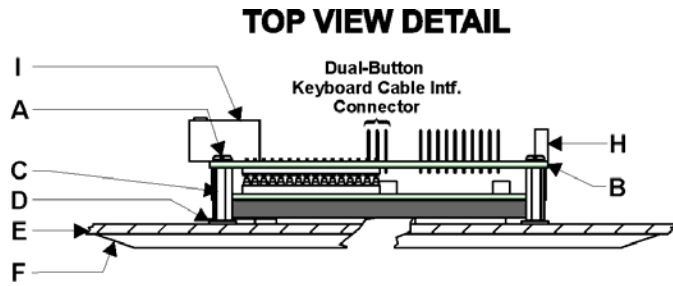
TOP VIEW DETAIL

Dual-Button
Keyboard Cable Intf.
Connector

A = Screw (Qty. 4)
B = Display/Keypad Sub-Ass'y.
C = .563" F/F Standoff (Qty. 4)
D = Washer (Qty. 4)
E = Instrument Front Cover
F = Bezel
G = #4 Washer & Nut (Qty. 2)
H = Brightness Adj. Pot.
I = RJ-45 Interface Jack

ITEM   LIST
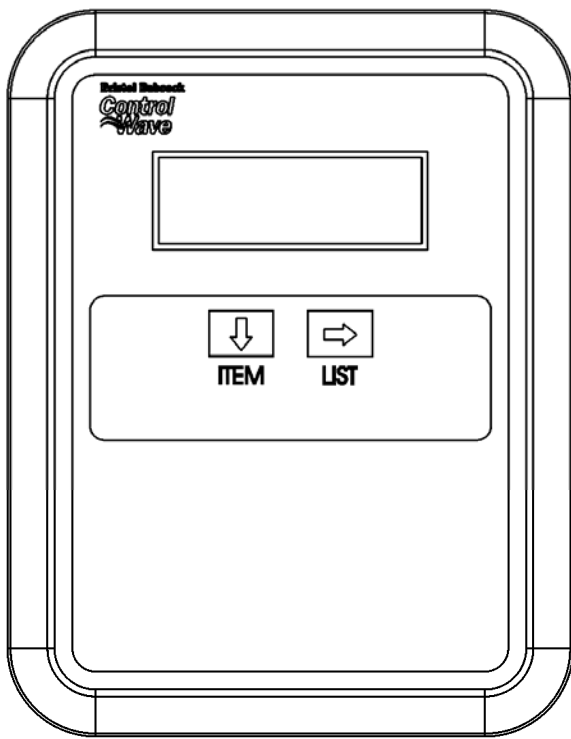
FRONT VIEW
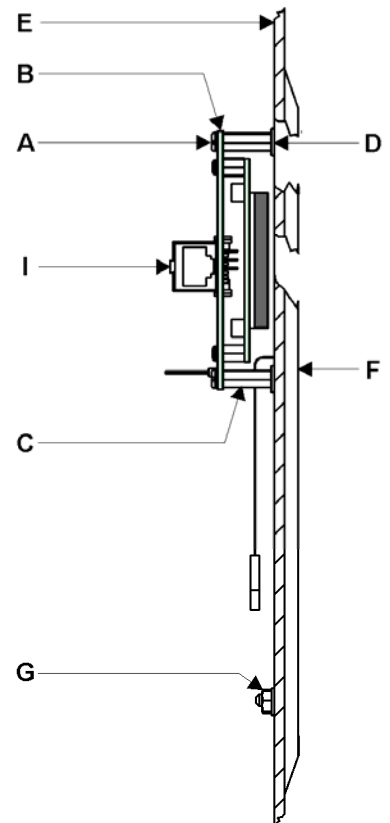
RIGHT SIDE VIEW DETAIL

Figure 2-48 - Dual-Button Display/Keypad Assembly Installation Drawing
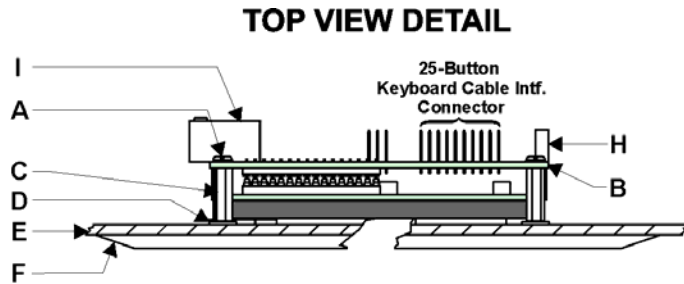
TOP VIEW DETAIL

25-Button
Keyboard Cable Intf.
Connector

A = Screw (Qty. 4)
B = Display/Keypad Sub-Ass'y.
C = .563" F/F Standoff (Qty. 4)
D = Washer (Qty. 4)
E = Instrument Front Cover
F = Bezel
G = #4 Washer & Nut (Qty. 2)
H = Brightness Adj. Pot.
 I = RJ-45 Interface Jack

Bristol Babcock
Control
Wave

| F1 | F2 | F3 | F4 |

| 7 | 8 | 9 | △ | ▽ | INIT |

| 4 | 5 | 6 | ALM I/E | ALM ACK |

| 1 ON | 2 | 3 | A/M | OPER I/E |

| — | 0 OFF | ○ | DEL | ENTER |
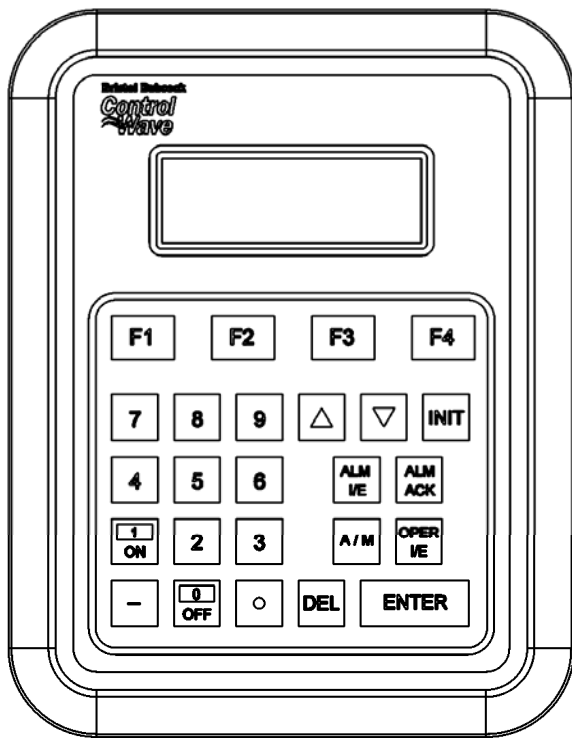
FRONT VIEW
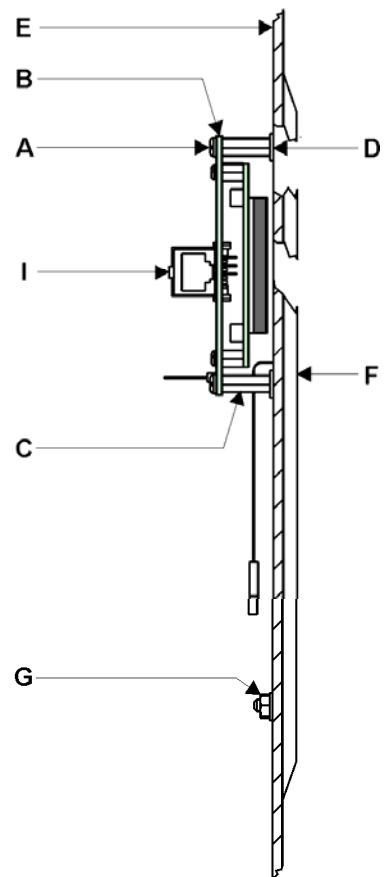
RIGHT SIDE VIEW DETAIL

Figure 2-49 - 25-Button Display/Keypad Assembly Installation Drawing

2.4.5.1 Operation of the Dual-button Display/Keypad Assembly

The Display will have a timeout of 20 minutes. If there has been no keypad activity for this time the display will "logout," i.e., the display will be turned off and scrolling stopped until a key press occurs. When a key press occurs after a timeout the display will return to the opening screen.

If a shorter timeout of the display is needed for power savings, another timeout may be implemented. The processor connected to the display will control the timeout. When the timeout occurs the display will be blanked, but communications between the ARM and display processor will still occur. The display processor will ignore posting the messages to the screen when in the low power mode. When a key is pressed the display processor will return to displaying information to the display.

Displays are organized into screens as follows:

Opening Screen: User defined strings

List Selection Screen: List Name
                                List Number
                                <Blank Line>
                                <Blank Line>

The List Selection screen is entered from the main opening screen by pressing the right arrow. Once here the operator can select which list is to be viewed. The operator can traverse though different list numbers by pressing the down arrow key. When the list to be scrolled is shown on the display, pressing the right arrow key will bring the operator to the Display Element screen.

Display Element Screen: <Blank Line>
                              <Blank Line>
                              Variable Name
                              Variable Name

The Display Element screen is entered from the list selection screen by pressing the right arrow. Once here the operator can view the variables in the list. Once entered the first element of the list is displayed and then next element will be displayed after the scroll timeout occurs. The scrolling will continue displaying the next element in the list and then wrapping around to the beginning of the list. The down arrow key will toggle the display through hold and scroll mode. Pressing the right arrow key will bring the operator to the list selection screen.

Display/Keypad Assemblies are supported by **Automatic Mode** and **Manual Mode**.

In Automatic Mode a set of screens (based on the application load) are displayed. The application programmer provides strings for the opening screen. From there the firmware is responsible for displaying the screens and responding to key presses. Screens are fixed and start off with an opening screen, which displays user information passed into the function block. Users can view a list to select which list is to be scrolled. Once the list to be scrolled has been selected, the user can scroll through the list by pressing the down arrow key. List elements will be displayed automatically, scrolling at a predetermined rate (determined by iiScrollTime). The user may pause on a variable by pressing the right arrow key. Pressing the right arrow key again will cause the list to start scrolling again.

The essence of Automatic Mode is that the user can supply inputs into the function that will determine which list can be displayed, but cannot change the menu or display. The user is allowed to select a list and to start/stop scrolling.

Manual Mode

In Manual Mode the programmer is responsible for creating each screen and displaying the next desired screen, based on key inputs. The programmer has access to all lines of the display and can provide any string that he/she desires to display. Special formats that must be adhered to that allow the programmer to display what they want on the screen are provided in the description of iaScrnSruct in the ACCOL 3 Display function block within ControlWave Designer's On-Line Help. It should be noted that currently, Manual Mode does not support reading Keypad keypresses. **Note: Manual Mode operation requires ControlWave Firmware 4.50 or newer.**

Section 3
SERVICE

3.1 SERVICE INTRODUCTION

This section provides general, diagnostic and test information for the **Control**Wave **EFM**.

The service procedures described herein will require the following equipment:

1. PC with null modem interface cable & Bristol's WINDIAG Software
2. Loop-back plug, 9-pin female D-Sub (for RS-232) (see Figure 3-9)
3. Loop-back plug, 9-pin female D-Sub (for RS-485) (see Figure 3-10)

The following test equipment can be used to test the Power Supply/Sequencer Module:

1. DMM (Digital Multimeter):   5-1/2 digit resolution
2. Variable DC Supply: Variable to 30Vdc @ 2.5A (with vernier adjustment)

When **Control**Wave **EFM** electronic flow meters are serviced on site, it is recommended that any associated processes be closed down or placed under manual control. This precaution will prevent any processes from accidentally running out of control when tests are conducted.

Warning

> *Harmful electrical potentials may still be present at the field wiring terminals even though the **Control**Wave **EFM's** power source may be turned off or disconnected. Do not attempt to unplug termination connectors or perform any wiring operations until all the associated supply sources are turned off and/or disconnected.*

Warning

> *Always turn off the any external supply sources used for externally powered I/O circuits, before changing any modules.*

3.2 COMPONENT REMOVAL/REPLACEMENT PROCEDURES

This section provides information on accessing **Control**Wave **EFM** modules for testing, as well as removal/replacement procedures.

3.2.1 Accessing Modules For Testing

Testing and replacement of **Control**Wave **EFM** modules should only be per-formed by technically qualified persons. Familiarity with the disassembly and test procedures described in this manual are required before starting. Any damage to the **Control**Wave **EFM** resulting from improper handling or incorrect service procedures will not be covered under the product warranty agreement. If these procedures cannot be performed properly, the unit should be returned to Bristol (with prior authorization from Bristol Inc.) for factory evaluation and repairs.

3.2.2 Removal/Replacement of the Bezel Assembly

Before I/O Modules can be removed, the Bezel Assembly, which covers them, must be removed.

1. Grasp the sides of the Bezel Assembly and gently lift it up and then pull it out and off its associated I/O Module Covers.
2. To replace the Bezel Assembly, first align the latches (left and right, top and bottom) with the associated I/O Module Cover notches. Press the Bezel in so that its latches can be captured by the notches, and slide it downward until it seats and is secured.

3.2.3 Removal/Replacement of the CPU Module

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Disconnect any CPU Module Communication Cables, making sure they are identified so they can be returned to their assigned Comm. Ports.
3. Press down on the Cover's built-in top latch (with one hand) and up on the Cover's built-in bottom latch (with the other hand).
4. Carefully slide the CPU Module out of the front of the Housing. If binding occurs, gently rock the module up and down to free it.
5. To replace a CPU Module, power must be off. Carefully align the CPU Module with **Control**Wave **EFM** Slot 2 and insert the unit into the Housing. When the assembly is fully seated, its cover should be latched to the Housing.
6. Replace any Comm. Cables and then apply power and test the unit.

3.2.4 Removal/Replacement of the System Controller Module

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Unplug the SCM's modular connectors.
3. Press down on the Cover's built-in top latch (with one hand) and up on the Cover's built-in bottom latch (with the other hand).
4. Carefully slide the SCM Module out of the front of the Housing. If binding occurs, gently rock the module up and down to free it.
5. To replace the SCM Module, power must be off. Carefully align the SCM Module with **Control**Wave **EFM** Slot 1 and insert the unit into the Housings. When the assembly is fully seated, its cover should be latched to the Housing.
6. Replace Power and Watchdog cables and then apply power and test the unit.

3.2.5 Removal/Replacement of an I/O Module

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Remove the applicable Bezel Assembly (see Section 3.2.2).
3. Unplug local termination cable headers from I/O Module connectors TB1 and TB2 or remote termination cables headers from connectors P3 and P4 and set the cables aside. Make sure these cables are identified so they can be returned to their assigned connectors.

4. Press down on the Cover's built-in top latch (with one hand) and up on the Cover's built-in bottom latch (with the other hand).
5. Carefully slide the I/O Module out of the front of the Housing. If binding occurs, gently rock the I/O Module up and down to free it.
6. To replace an I/O Module, power must be off. Carefully align the I/O Module with the applicable I/O Slot and insert the unit into the Housing. When the assembly is fully seated, its cover should be latched to the Housing.
7. Connect local termination cables to I/O Module connectors TB1 and TB2 or remote termination cables to I/O Module connectors P3 and P4.
8. Apply power and test the unit.

3.2.6 Removal/Replacement of an Expansion Comm. Module

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Disconnect any Expansion Comm. Module Communication Cables, making sure they are identified so they can be returned to their assigned Comm. Ports.
3. Press down on the Cover's built-in top latch (with one hand) and up on the Cover's built-in bottom latch (with the other hand).
4. Carefully slide the Expansion Comm. Module out of the front of the Housing. If binding occurs, gently rock the module up and down to free it.
5. To replace a Expansion Comm. Module, power must be off. Carefully align the Expansion Comm. Module with **Control**Wave **EFM** Slot 3 or 4 (as required) and insert the unit into the Housing. When the assembly is fully seated, its cover should be latched to the Housing.
6. Replace any Comm. Cables and then apply power and test the unit.

3.2.7 Removal/Replacement of a Rechargeable Lead-acid Battery

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Disconnect the power cables from the battery terminals (remove screw and nut on each terminal).
3. Loosen the two 11/32" nuts on the ends of the Battery Clamp. Lift the Battery Clamp and rotate it rearward.
4. Carefully lift up and remove the Rechargeable Lead-acid Battery.
5. To replace the Rechargeable Lead-acid Battery, align the unit such that the negative battery terminal is oriented to the top and right as illustrated in Figure 3-1 and place the battery into the Battery Mounting Bracket (Battery Clamp must be in the released position. **Note: Make sure the Lead-acid Battery is fully charged before installing it.**
6. Raise the Battery Clamp and rotate it forward until it can be lowered to secure the Rechargeable Lead-acid Battery. Tighten the two 11/32" nuts on the ends of the Battery Clamp.
7. Replace the power cables to the battery terminals (black/NEG, Red/POS).
8. Apply power (replace SCM Power Connector - TB1) and test the unit.

Rotate Battery Clamp Forward (as shown) to Clamp Battery

Install or Remove Battery Clamp in Unclamped Position

To Remove the Battery:
Loosen the two (2) 11/32 Nuts.
Lift Latch and Rotate it Rearward.

In Clamped Position

3

1

2

RECHARGEABLE SEALED LEAD-ACID BATTERY

1 = Battery Mounting Bracket
2 = Battery Mounting Bracket (Screws)(Qty. 6)
3 = Battery Clamp
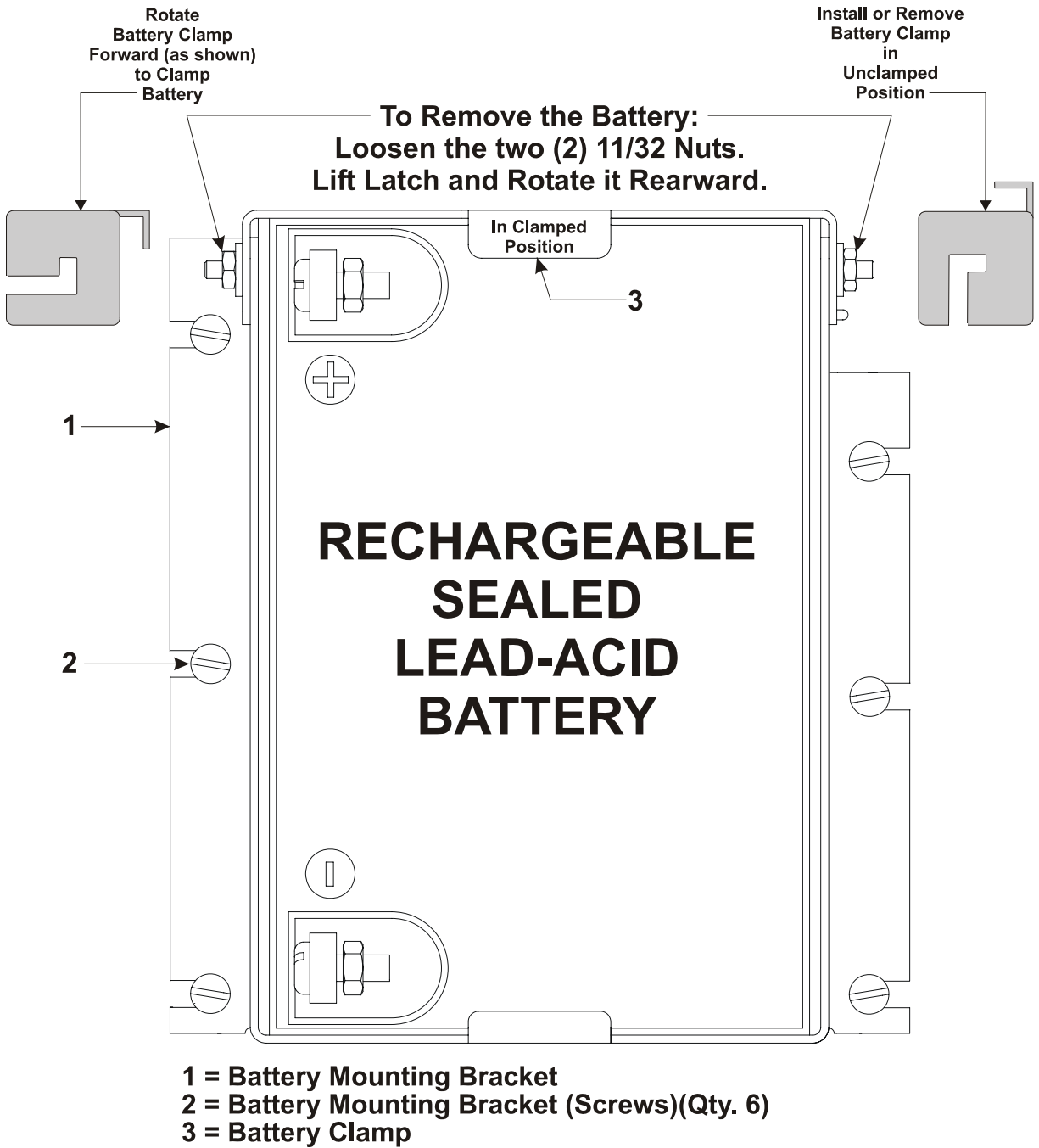
Figure 3-1 - Sealed Lead-acid Battery Mounting Diagram

3.2.8 Removal/Replacement of a Power Distribution Board

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Unplug wiring harnesses from Power Distribution Board connectors TB1 through TB6 (make sure cables are identified for proper replacement).
3. Slide the Power Distribution Board toward the front of the unit and remove it from its Snap Track Holder.
4. To replace a Power Distribution Board, slide it into its Snap Track Holder. Replace wiring harness connectors TB1 through TB6.
5. Apply power (replace SCM Power Connector - TB1) and test the unit.

3.2.9 Removal/Replacement of a 21V Power Supply Board

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control (as required).
2. Unplug wiring harnesses from 21V Power Supply Board connectors TB1 and TB2.
3. Slide the 21V Power Supply Board toward the front of the unit and remove it from its Snap Track Holder.
4. To replace a 21V Power Supply Board, slide it into its Snap Track Holder. Replace wiring harness connectors TB1 and TB2.
5. Apply power (if necessary) and test the unit.

3.2.10 Removal/Replacement of a Digital to Relay I/O Board

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Unplug wiring harnesses from Digital to Relay I/O Board connector J1.
3. Slide the Digital to Relay I/O Board toward the front of the unit and remove it from its Snap Track Holder.
4. To replace a Digital to Relay I/O Board, slide it into its Snap Track Holder. Replace wiring harness connector J1/P1.
5. Apply power (replace SCM Power Connector - TB1) and test the unit.

3.2.11 Removal/Replacement of an External Radio/Modem

1. If the **Control**Wave **EFM** is running, place any critical control processes under manual control and shut down the unit by disconnecting power to the System Controller Module (SCM).
2. Remove the Sealed Lead-acid Battery (if present) (see Section 3.2.7).
3. Disconnect (unplug) all connectors (power and interface) from the Radio/Modem.
4. Remove the mounting screws from the bottom (inside) of the Battery Mounting Bracket and remove the Radio/Modem (with Mounting Plate if present).
5. Replace the Radio/Modem in the reverse order from which it was removed.
6. Apply power (replace SCM Power Connector - TB1) and test the unit.

3.3 TROUBLESHOOTING TIPS

3.3.1 System Controller Module (SCM) Voltage Checks

One bulk power source can be connected to the SCM. SCM connector TB1 provides 3 input terminal connections for bulk power (see Figure 3-2):

TB1-1 = (+VIN) (+4.5/4.9V to +16V dc for +6V supply) (+9.6/10.3V to +16V dc for +12V supply)
TB1-2 = (-VIN) (Supply Ground)
TB1-3 = Chassis Ground - CHASSIS (⏚)

Bulk supply voltages can be checked at TB1 using a voltmeter or multimeter. SCM's are factory configured for use with a nominal 6Vdc or 12Vdc bulk power supply. The maximum and minimum input power switch-points can be tested with the use of a Variable dc Power Supply connected between TB1-1 (+) and TB1-2 (-). By increasing the input voltage (starting at less than +4.5Vdc or less than +9.6Vdc) for +6V or +12V units respectively, you can determine the point at which the unit will turn on, i.e., the point at which the green PWRGOOD LED on the SCM comes ON (Vt+). By decreasing the input voltage (starting at

+16Vdc), you can determine the point at which the unit turns off, i.e., the point at which the PWRGOOD LED on the SCM goes OFF (Vt-). If the value of the bulk power supply's +6Vdc or +12Vdc output approaches the value of Vt+ or Vt- it should be replaced by a power supply with the correct +6V or +12V output.
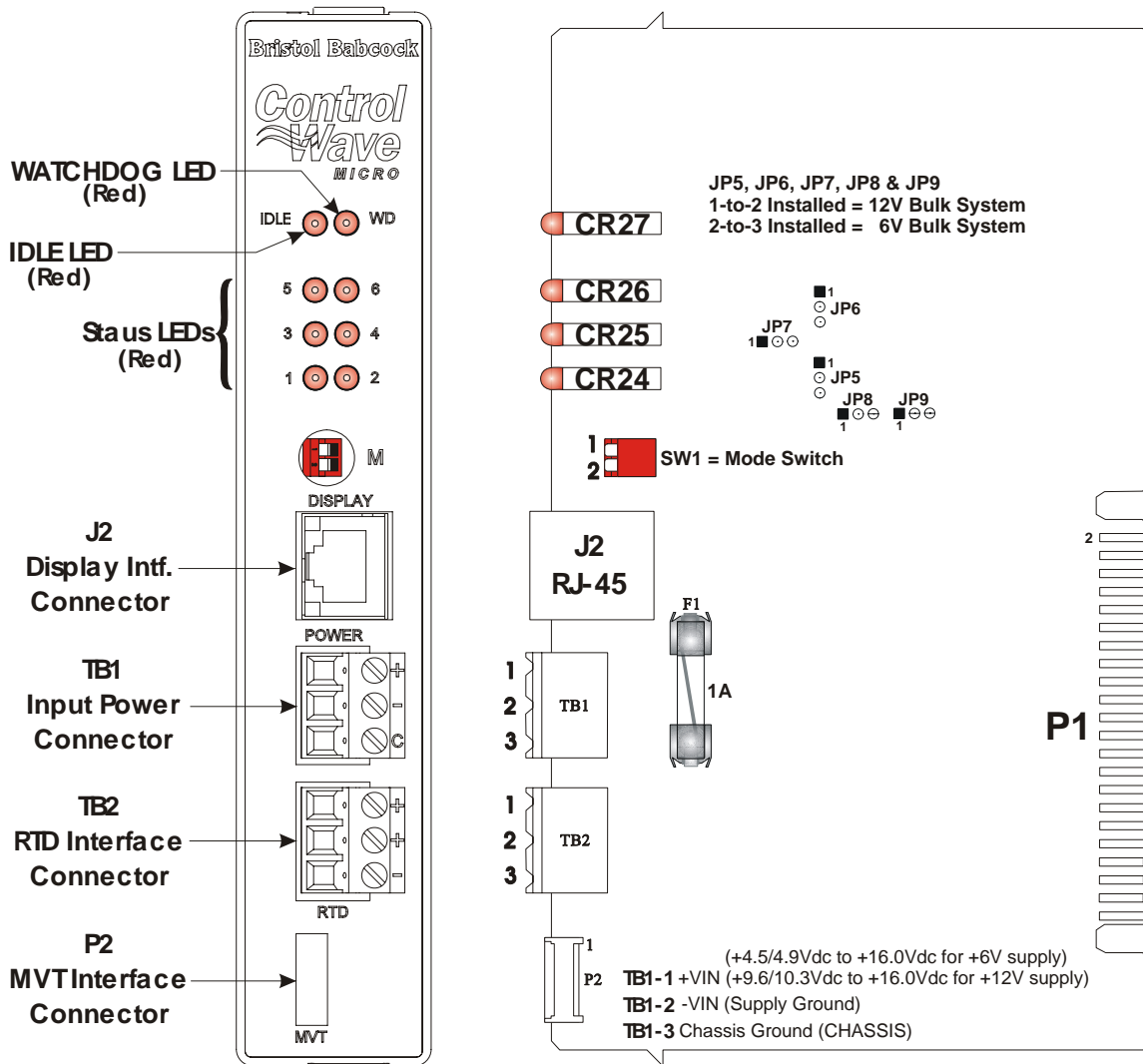
Figure 3-2 - System Controller Module's Component & LED Designations

3.3.2 LED Checks

All **Control**Wave **EFM** Modules contain light emitting diodes (LEDs) that provide operational and diagnostic functions. A brief synopsis of the individual module LEDs is provided as follows:

SCM: 1 IDLE LED, 1 Watchdog LED, & 6 System Status LEDs
CPUM: 2 LEDs per Comm. Port = 6
ECOM1: 2 LEDs per Comm. Port = 8
ECOM2: 2 LEDs per Comm. Port = 8
AI/OM: None
DI/OM: 1 LED per DI x 12 = 12 DI LEDs, 1 LED per DO x 4 = 4 DO LEDs
HSCM: 1 LED per HSC x 4 = 4 HSC LEDs
MI/OM: None

ControlWave **EFM** LED designations are provided in Table 3-1.

<p style="text-align: center;">Table 3-1 - LED Assignment</p>

Module	LED Name	LED Color	Function
SCM *	IDLE	Red	ON = Idle
SCM *	WD	Red	ON = Watchdog Condition - OFF = Normal
SCM	6 STATUS	Red	See Table 3-2 & Figure 3-2
CPUM	C1 RX (Comm 1)	Red	ON = RX Activity (Top-Left - see Fig. 3-4)
CPUM	C1 TX (Comm 1)	Red	ON = TX Activity (Top-Right -see Fig. 3-4)
CPUM	C2 RX (Comm 2)	Red	ON = RX Activity (Middle-Left - see Fig. 3-4)
CPUM	C2 TX (Comm 2)	Red	ON = TX Activity (Middle-Right -see Fig. 3-4)
CPUM	C3 RX (Comm 3)	Red	ON = RX Activity (Bottom-Left - see Fig. 3-4)
CPUM	C3 TX (Comm 3)	Red	ON = TX Activity (Bottom-Right -see Fig. 3-4)
ECOM1	C1 RX (Comm 4)	Red	ON = RX Activity (Top-Left - see Fig. 3-6)
ECOM1	C1 TX (Comm 4)	Red	ON = TX Activity (Top-Right -see Fig. 3-6)
ECOM1	C2 RX (Comm 5)	Red	ON = RX Activity (2nd from Top-Left - see Fig. 3-6)
ECOM1	C2 TX (Comm 5)	Red	ON = TX Activity (2nd from Top-Right -see Fig. 3-6)
ECOM1	Radio RX (Comm 6)	Red	ON = RX Activity (3rd from Top-Left - see Fig. 3-6)
ECOM1	Radio TX (Comm 6)	Red	ON = TX Activity (3rd from Top-Right -see Fig. 3-6)
ECOM1	Modem RX (Comm 7)	Red	ON = RX Activity (Bottom-Left - see Fig. 3-6)
ECOM1	Modem TX (Comm 7)	Red	ON = TX Activity (Bottom-Right -see Fig. 3-6)
ECOM2	C1 RX (Comm 8)	Red	ON = RX Activity (Top-Left - see Fig. 3-6)
ECOM2	C1 TX (Comm 8)	Red	ON = TX Activity (Top-Right -see Fig. 3-6)
ECOM2	C2 RX (Comm 9)	Red	ON = RX Activity (2nd from Top-Left - see Fig. 3-6)
ECOM2	C2 TX (Comm 9)	Red	ON = TX Activity (2nd from Top-Right -see Fig. 3-6)
ECOM2	Radio RX (Comm 10)	Red	ON = RX Activity (3rd from Top-Left - see Fig. 3-6)
ECOM2	Radio TX (Comm 10)	Red	ON = TX Activity (3rd from Top-Right -see Fig. 3-6)
ECOM2	Modem RX (Comm 11)	Red	ON = RX Activity (Bottom-Left - see Fig. 3-6)
ECOM2	Modem TX (Comm 11)	Red	ON = TX Activity (Bottom-Right -see Fig. 3-6)
DI/OM	Input (12 LEDs) (1 Per Point)	Red	LED ON = Input is present LED OFF = Input is not present (see Fig. 3-5)
DI/OM	Output (4 LEDs) (1 Per Point)	Red	LED ON = Output is ON (see Fig. 3-5)
HSCM	INPUT (4 LEDs) (1 Per Point)	Red	LED ON = Input activity on input is present LED OFF = No activity on input (see Fig. 3-5)

* = see Figure 3-2

<p style="text-align: center;">Table 3-2 - System Status LED Codes on System Controller Module</p>

Status (Hex)	LED 6	LED 5	LED 4	LED 3	LED 2	LED 1	Indication Definition
00	0	0	0	0	0	0	Application Running
01	0	0	0	0	0	1	Unit in Diagnostic Mode
03	0	0	0	0	1	1	Unit Running Diagnostics
04	0	0	0	1	0	0	Flash XSUM Error
05	0	0	0	1	0	1	Error Initializing Application Device
07	0	0	0	1	1	1	Flash Programming Error
08	0	0	1	0	0	0	Using Factory Defaults *
09	0	0	1	0	0	1	Battery Failure Detected *
0A	0	0	1	0	1	0	Currently Loading the Boot Project
0B	0	0	1	0	1	1	System Initialization in Progress
10	0	1	0	0	0	0	Waiting in Recovery Mode

Status (Hex)	LED 6	LED 5	LED 4	LED 3	LED 2	LED 1	Indication Definition
11	0	1	0	0	0	1	Error Testing SDRAM
12	0	1	0	0	1	0	Error Testing SRAM
20	1	0	0	0	0	0	Application Loaded
28	1	0	1	0	0	0	Stopped at a Break Point
30	1	1	0	0	0	0	No Application Loaded
38	1	1	1	0	0	0	Running with Break Points
3B	1	1	1	0	1	1	Waiting for Power-down (after NMI)
3E	1	1	1	1	1	0	Waiting for Updump to be Performed
3F	1	1	1	1	1	1	Unit Crashed (Watchdog Disabled)

* = Flashed at startup
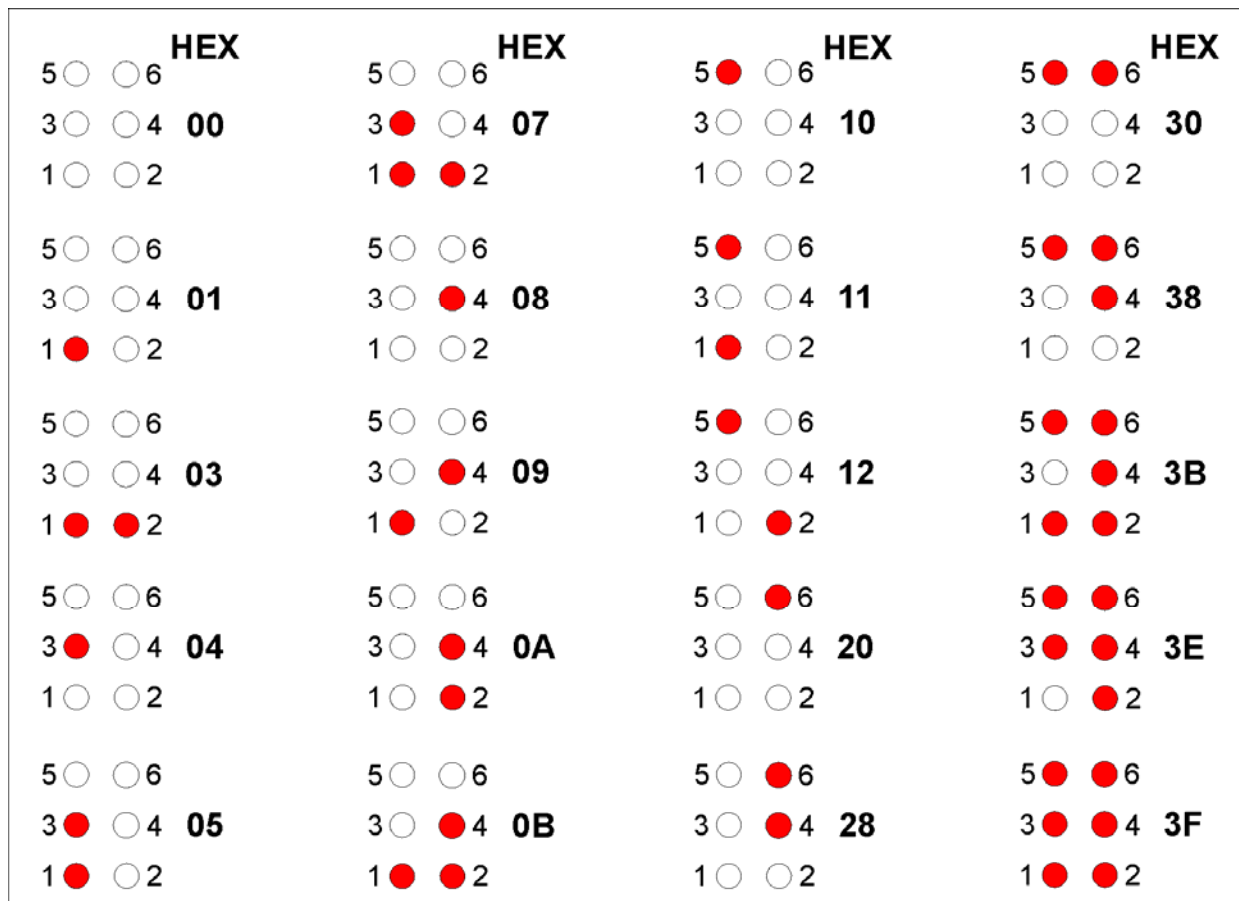
Figure 3-3 - System Controller Module Status LED Hexi-decimal Codes (See Table 3-2 for Definitions)
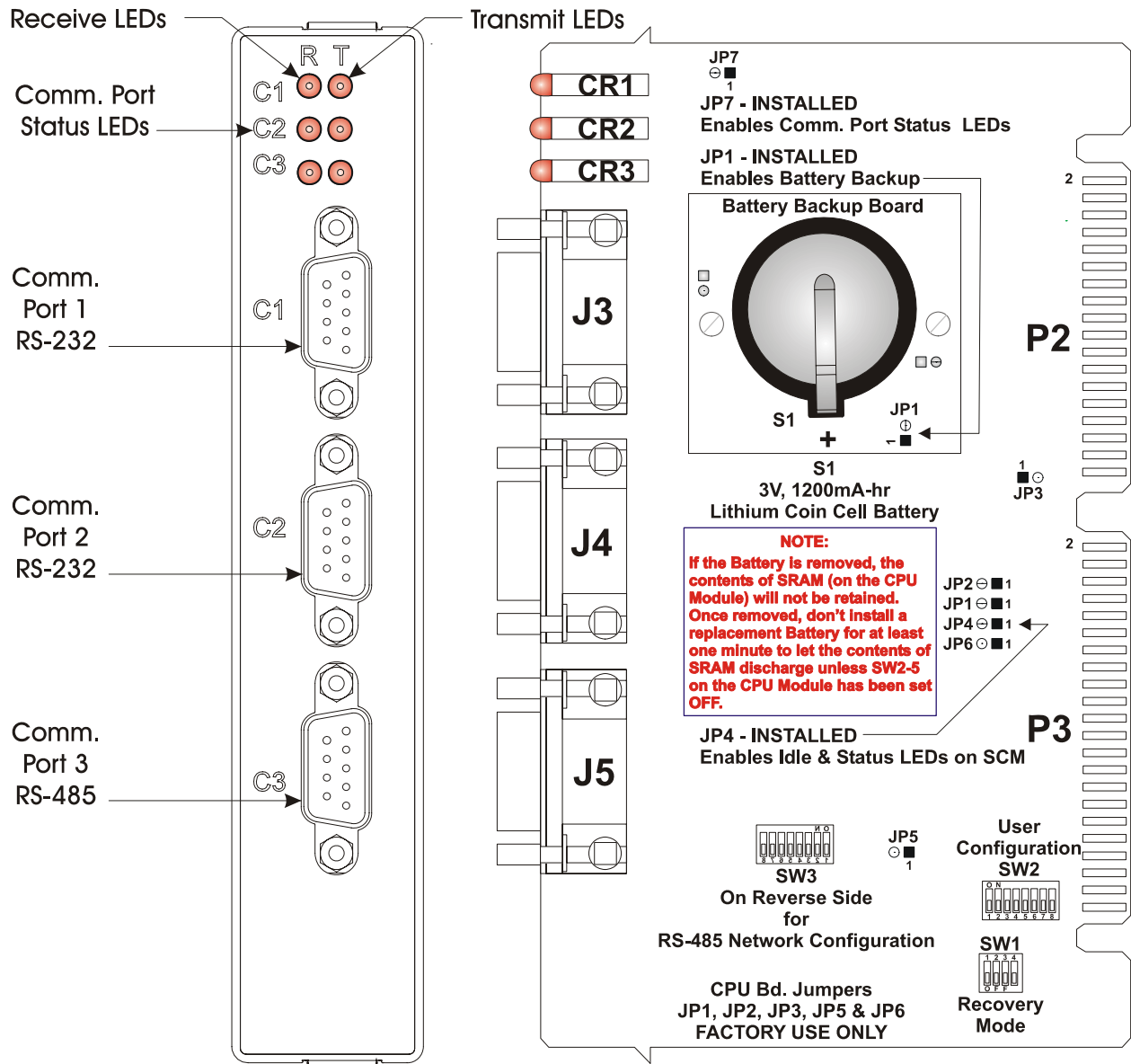
Figure 3-4 - CPU Module Communication Connector and LED Designations
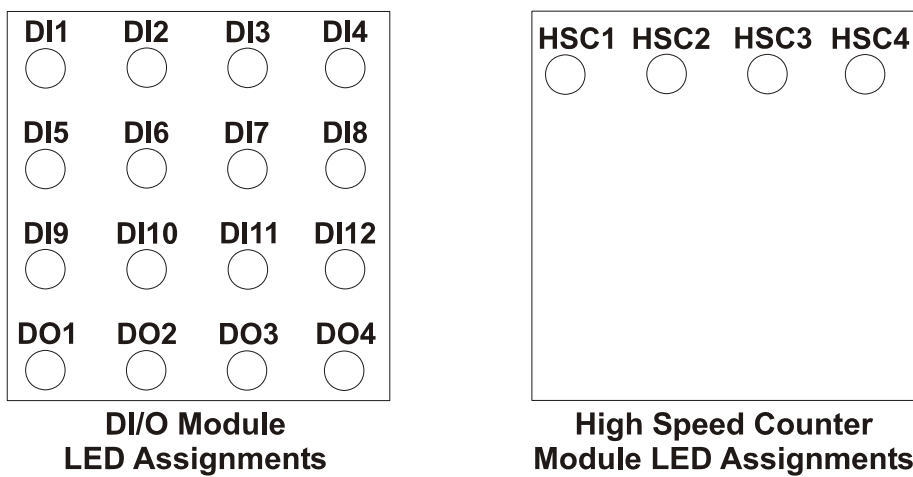
Figure 3-5 - Control Wave **EFM Plus I/O Module LED Designations**
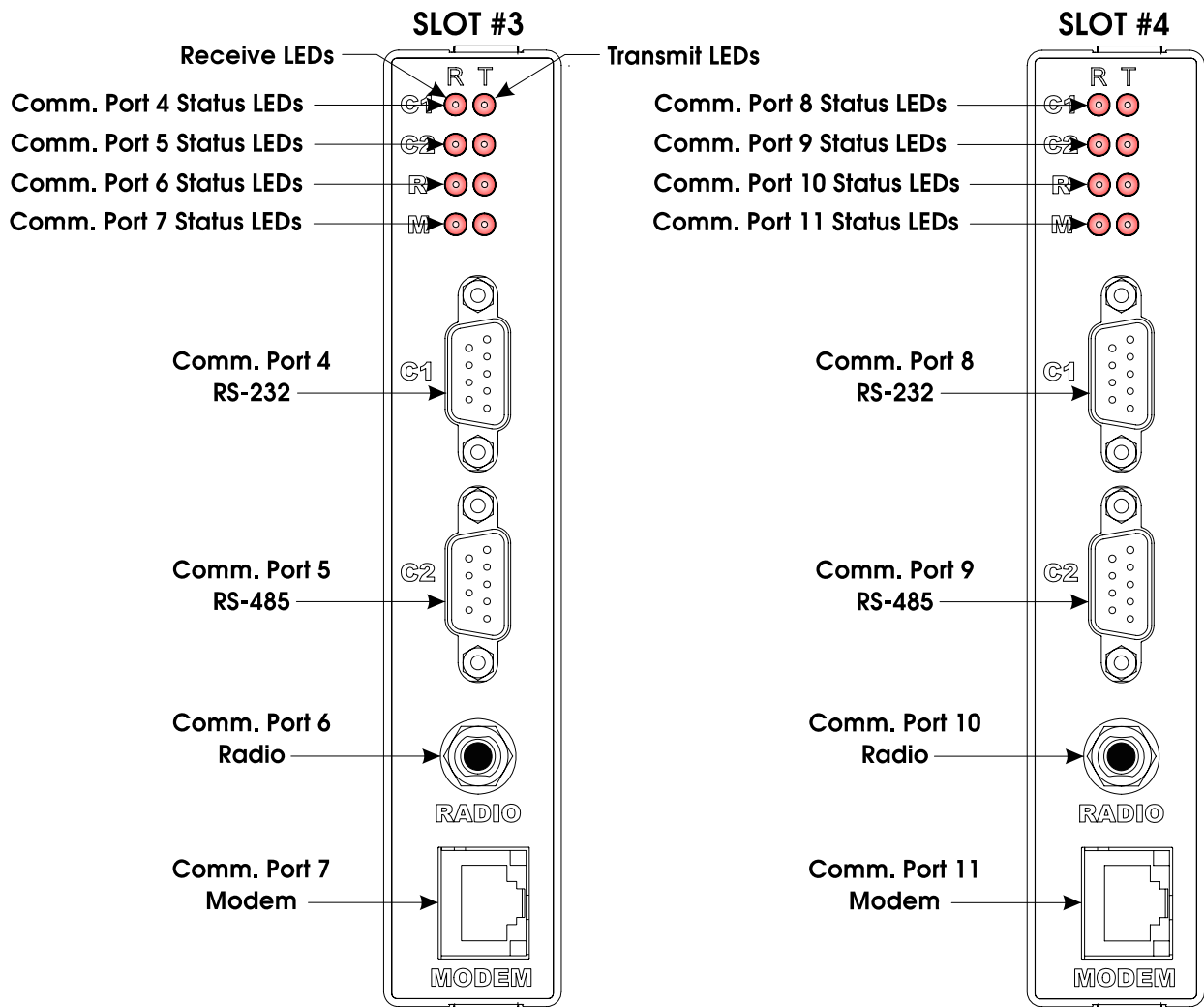
Figure 3-6 - Expansion Comm. Module - Comm. Connector and LED Designations

3.3.3 Wiring/Signal Checks

Check I/O Field Wires at the Card Edge Terminal Blocks and at the field device. Check wiring for continuity, shorts & opens. Check I/O signals at their respective Terminal Blocks (see Table 3-3).

Table 3-3 - I/O Field Wiring - Terminal Block Reference List

I/O Subsystem	Figures	Notes
Digital I/O	2-19	See Section 2.3.4.4
Analog I/O	2-20	See Section 2.3.4.5
HSC Inputs	2-21	See Section 2.3.4.6
Mixed I/O	2-22	See Section 2.3.4.7

3.4 GENERAL SERVICE NOTES

Certain questions or situations frequently arise when servicing the **Control**Wave **EFM**. Some items of interest are provided in Sections 3.4.1 through 3.4.4.

3.4.1 Extent of Field Repairs

Field repairs to a **Control**Wave **EFM** are strictly limited to the replacement of complete modules. Component replacement on a **Control**Wave **EFM** Module constitutes tampering and will violate the warranty. Defective **Control**Wave **EFM** Housings or Modules must be returned to Bristol Inc. for authorized service.

3.4.2 Disconnecting RAM Battery

The **Control**Wave **EFM's** Lithium RAM battery cannot be replaced while power is on. Once the RAM battery has been replaced, the unit will still execute its FLASH-based application load (Boot Project) upon power-up, but all of the current process data will have been lost. Upon power-up, the unit will act as though it had just been booted and it will revert back to the initial values specified in its application load. The battery may be disabled by removing CPU Module Battery Backup Board Jumper, JP1.

3.4.3 Maintaining Backup Files

It is essential to maintain a backup disk of each application load file to guard against an accidental loss of process configuration data. Without a backup record, it will be necessary to reconfigure the entire application load; that can be a very time consuming procedure. Always play it safe and keep backup copies of your operating system loads. A copy of the application load can be loaded into **Control**Wave **EFM** FLASH memory and/or saved to a PC's Hard Drive as a ZIP file.

3.5 WINDIAG DIAGNOSTICS

Bristol's WINDIAG Software is a diagnostic tool used for testing **Control**Wave **EFM** I/O Modules, CPU memory, communications ports, etc., for proper performance. The **Control**Wave **EFM** must be communicating with a PC equipped with the WINDIAG program. CPU Module configuration switch SW2-8 must be set to the OFF (Closed) position to enable diagnostics. Communication between the **Control**Wave **EFM** (with/without application loaded) and the PC can be made via a Local or Network Port with the following restrictions:

- CPU Board Switch SW2-8 must be OFF to run the WINDIAG program. Setting SW2-8 OFF will prevent the 'Boot Project' from running and will place the unit into diagnostic mode.
- Any **Control**Wave **EFM** communication port can be connected to the PC (PEI) provided their port speeds match. Most PCs have a COM1 port (typically RS-232 and defaulted to 9600 bps operation).
- Setting CPU Board Switches SW2-3 and SW2-8 OFF prevents the 'Boot Project' from running, places the unit into diagnostic mode and forces communication ports COM1, COM2, COM3, COM4, COM5, COM8 and COM9 to operate at 9600 baud.

COM1: From the factory, RS-232 Communications Port COM1 defaults to 115.2 kbd (RS-232) using the Internet Point to Point Protocol (PPP). *Note: Port COM1 will be configured for RS-232 operation (at 9600 baud) by setting CPU Switches SW2-3 and SW2-8 OFF. This will prevent the boot project from running and places the unit into diagnostic mode.* To test COM1 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. Connection to a PC requires the use of an RS-232 "Null Modem" cable (see Figure 2-12).

COM2: From the factory, RS-232 Communications Port COM2 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM2 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF.

COM3: RS-485 Communications Port COM3 on the CPU Board defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM3 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-3 & 2-5) can be connected between COM3 and the PC's RS-485 Port.

COM4: From the factory, RS-232 Communications Port COM4 on the first optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM4 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. When required, an RS-232 "Null Modem" cable be connected between COM4 and the PC (typically COM1) (see Figure 2-12).

COM5: RS-485 Communications Port COM5 on the first optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/ControlWave Designer protocol operation. To test COM5 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-3 & 2-4) can be connected between COM5 and the PC's RS-485 Port.

COM8: From the factory, RS-232 Communications Port COM8 on the second optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM8 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. When required, an RS-232 "Null Modem" cable be connected between COM8 and the PC (typically COM1) (see Figure 2-12).

COM9 RS-485 Communications Port COM9 on the second optional Expansion Communications Module defaults to 9600 baud, 8-bits, no parity, 1 stop bit, BSAP/**Control**Wave Designer protocol operation. To test COM9 using the WINDIAG program, it must not otherwise be in use and CPU Switch SW2-8 must be set OFF. In lieu of the use of an RS-232 Port, an RS-485 cable (see Tables 2-3 & 2-4) can be connected between COM9 and the PC's RS-485 Port.

To use the WINDIAG program place any critical process (associated with the **Control**Wave **EFM** unit in question) under manual control. WINDIAG cannot be run while the **Control**Wave **EFM** application is running. Set the CPU Modules Switch SW2-8 to the OFF position. Perform steps 1 through 6 below.

1. Start the OpenBSI NetView Program. A menu similar to Figure 3-7 will appear.

2. To start the WINDIAG program, go to the Start Program's menu, select OpenBSI Tools, then select Utilities Programs and then select Diagnostics.

3. Once WINDIAG has been entered, the Main Diagnostics Menu of Figure 3-8 will appear.
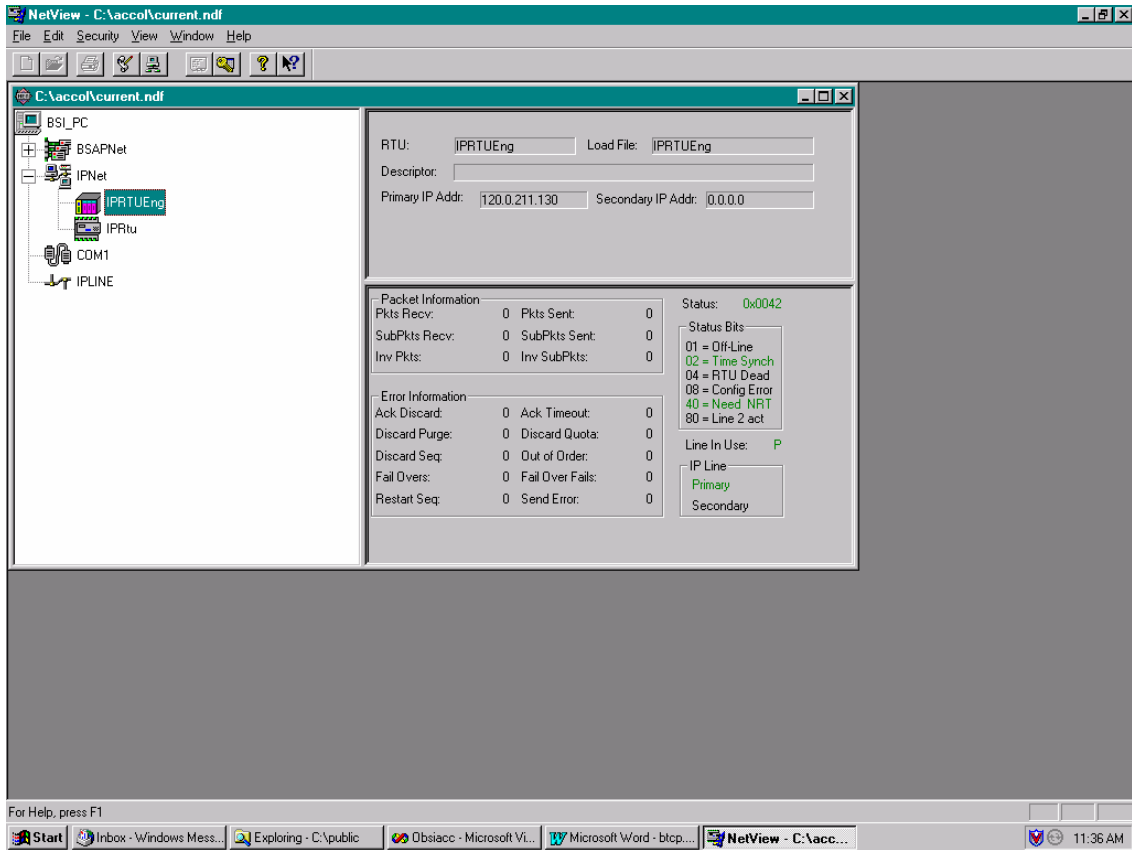
Figure 3-7 - Netview Startup Menu - Example with Multiple Networks
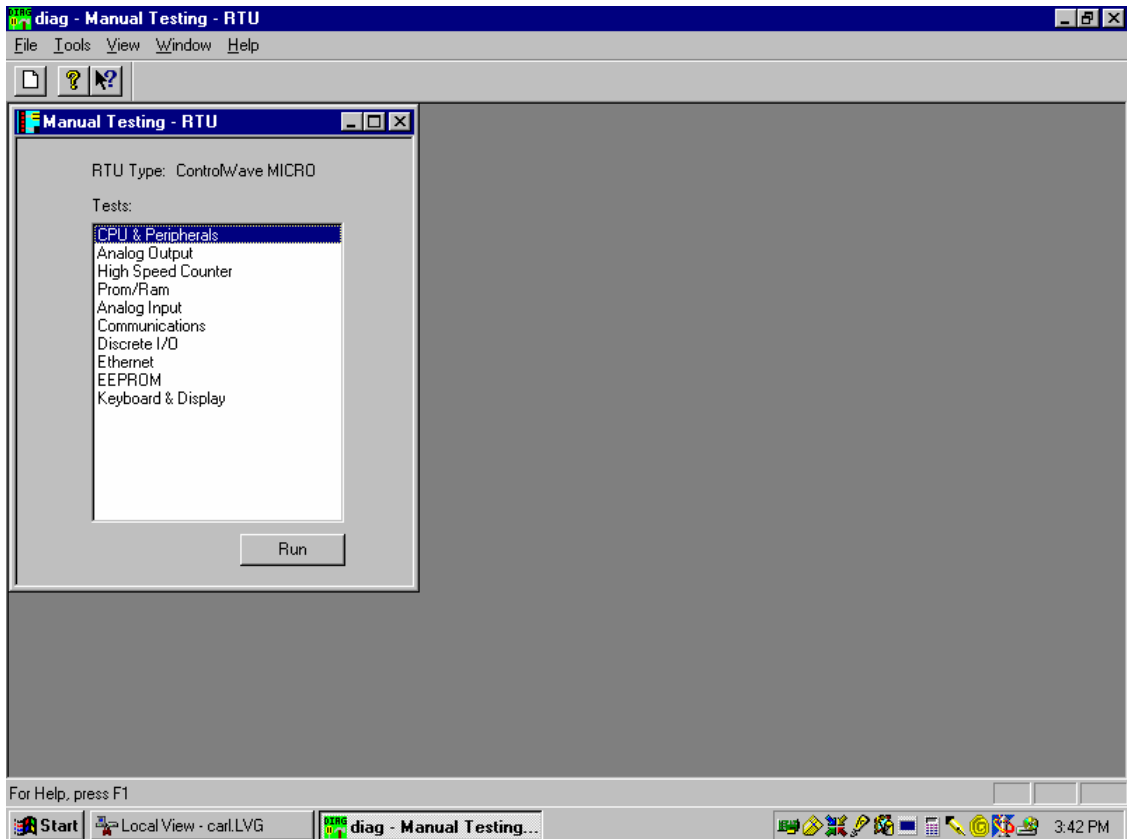
Figure 3-8 - WINDIAG Main Diagnostics Menu

4. Select the module to be tested. Enter any prompted parameters (slot #, etc.). WINDIAG will perform the diagnostics and display pass/fail results.

5. After all diagnostic testing has been performed, exit the WINDIAG program and then exit the Netview Program if there aren't any other **Control**Wave **EFM** units to be tested.

   When you close the Netview program you will be prompted as to whether or not you want to close the OpenBSI program; select Yes.

6. Set the **Control**Wave **EFM** CPU Switch SW2-8 to the ON (Open) position. The **Control**Wave **EFM** should resume normal operation.

3.5.1 Diagnostics Using WINDIAG

All **Control**Wave **EFM** Modules except the System Controller Module can be tested using the WINDIAG program. From WINDIAG's Main Diagnostics Menu (see Figure 3-8) the following diagnostic tests can be performed:

CPU & Peripherals Diagnostic: Checks the CPU Module (except for RAM & PROM).
PROM/RAM Diagnostic: Checks the CPU's RAM and PROM hardware.
Communications Diagnostic: Checks Comm. Ports 1, 2, 3, 4, 5, 8 and 9 - The External
                              loop-back tests require the use of a loop-back plug.
Analog Output Diagnostic: Checks AOs on AI/O & Mixed I/O Modules.
Analog Input Diagnostic: Checks AIs on AI/O & Mixed I/O Modules.
Discrete I/O Diagnostic: Checks DIs or DOs on DI/O & Mixed I/O Modules.
High Speed Counter Diagnostic: Checks HSCs on HSC & Mixed I/O Modules.

3.5.1.1 Communications Diagnostic Port Loop-back Test

WINDIAG's Communications Diagnostic Menu (see Figure 3-11) provides for selection of the communication port to be tested. Depending on the type of network (RS-232 or RS-485) and the port in question, a special loop-back plug is required as follows:

Ports 1, 2, 4 & 8 - RS-232 use a 9-pin female D-type loop-back plug (see Fig. 3-9).
Ports 3, 5 & 9 - RS-485 use a 9-pin female D-type loop-back plug (see Fig. 3-10).

This group of tests verifies the correct operation of the Communication Interface. COM1, COM2, COM3, COM4, COM5, COM8 and COM9 can be tested with this diagnostic. The **Control**Wave **EFM** communication port that is connected to the PC (local or network and used for running these tests) can't be tested until diagnostics has been established via one of the other ports, i.e., to test all **Control**Wave **EFM** communication ports (via WINDIAG), communications with the PC will have to be established twice (each time via a different port). It should be noted that the **Control**Wave **EFM** communication port that is connected to the PC (RS-232, RS-485 or Ethernet) must be good for WINDIAG to run the Communications Diagnostics

3.5.1.2 Serial Comm. Port External Loop-back Test Procedure

Connect an external loop-back plug to the CPU Port to be tested, i.e., J3 of CPU for COM1, J4 of CPU for COM2 2, J5 of CPU for COM3, J1 of ECOM1 for COM4, J2 of ECOM1 for COM5, J1 of ECOM2 for COM8 or J2 of ECOM2 for COM9 (see Figures 3-9 through 3-11).

**9-Pin
Female
"D" Connector**

4 = DTR

3 = TXD
2 = RXD

1 = DCD

8 = CTS
7 = RTS

5 9

1 6
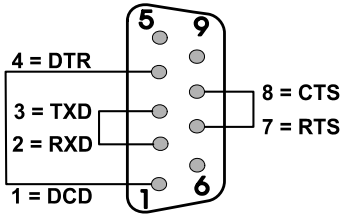
Figure 3-9 - RS-232 Loop-back Plugs

**9-Pin
Female
"D" Connector**

4 = TXD+

3 = TXD-

2 = RXD-

5 9

1 6

6 = RXD+
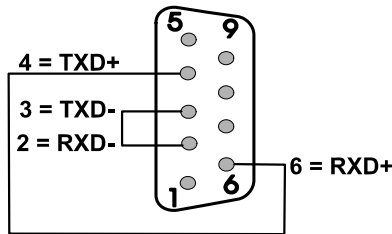
Figure 3-10 - RS-485 Loop-back Plugs
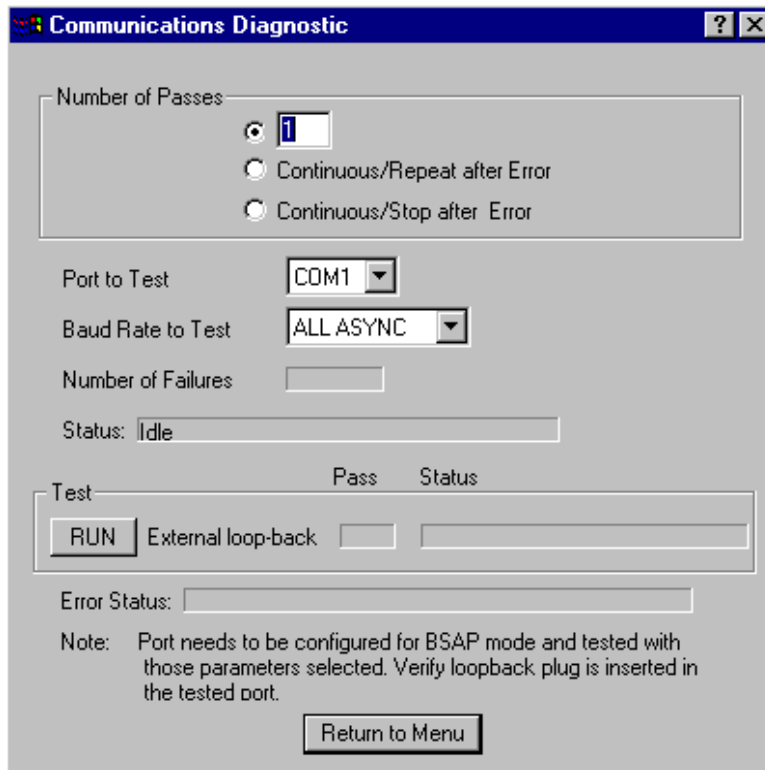
Figure 3-11 - WINDIAG's Communications Diagnostic Menu

1. Type "1," "2," "3," or "4" for the port to test.

2. Set baud rate to test to 115200 baud or ALL ASYNC and the number of passes to 5.

3. Click on RUN button next to External loop-back.

- Test responses:
     a) Success - All sections of test passed
     b) Failure   - TXD RXD Failure or CTS RTS Failure
- Execution time < 5 sec.

3.6 CORE UPDUMP

In some cases a copy of the contents of SRAM and SDRAM can be uploaded to a PC for evaluation by Bristol Inc. engineers. This upload is referred to as a 'Core Updump.' A Core Updump may be required if the **Control**Wave **EFM** electronic flow meter repeatedly enters a 'Watchdog State' thus ill effecting system operation. A Watchdog State is entered when the system crashes, i.e., a CPU timeout occurs due to improper software operation, a firmware glitch, etc. In some cases the Watchdog State may reoccur but may not be logically reproduced.

'Crash Blocks' (a function of firmware provided for watchdog troubleshooting) are stored in CPU RAM. The user can view and save the 'Crash Blocks' by viewing the Crash Block Statistic Web Page (see Chapter 4 of the Open BSI Technician's Toolkit - D5087). Crash Block files should be forwarded to Bristol Inc. for evaluation. If additional information is required to evaluate the condition, a Core Updump may be requested by Bristol. Once the file generated by the Core Updump has been forwarded to Bristol it will be evaluated and the results will be provided to the user.

Follow the five steps below to perform a Core Updump.

1. Set CPU Module Switch SW2-1 OFF (Disable Watchdog Timer). If SW2-4 is ON, set it to OFF (Enable Core Updump). **Note: The factory default setting for SW2-4 is OFF.**

2. Wait for the error condition (typically 3F on SCM Status LEDs).

3. Connect **Control**Wave **EFM** Comm. Port 1 to a PC using a Null Modem Cable (see Figures 2-12 and 2-13).

4. Set the System Controller's Mode Switch (SW1) so that both switches are in the **OPEN** (Right) position or the **CLOSED** (Left) position.

5. Start the PC's HyperTerminal Program (at 115.2kbaud) and generate a file using the 1KX-Modem protocol. Save the resulting Core Updump in a file to be forwarded to Bristol, Inc. for evaluation.

By setting CPU Module Switches SW2-1 OFF and SW2-4 OFF prior to the failure of a **Control**Wave **EFM**, it will not recover but will wait for the Core Updump to be taken. Once the Core Updump has completed, set the **Control**Wave **EFM** CPU Module's switch SW2-1 ON (Watchdog Enabled) and SW2-4 OFF (Core Updump Enabled) and the SCM's Mode Switch positions SW1-1 OPEN (right) and SW1-2 CLOSED (Left), i.e., for Local Mode, if required, and then power cycle the unit to recover and start running again.

3.7 CALIBRATION CHECKS

Calibration of the MVT and the RTD are performed using OpenBSI's TechView Program (see document # D5131 – TechView User's Guide).

Section 4
SPECIFICATIONS

4.1 CPU, MEMORY & PROGRAM INTERFACE

Processor: Sharp's LH7A400 32-bit System-on-Chip with 32-bit ARM9TDMI RISC Core

Memory: 8 Mbytes of simultaneous read/write FLASH
                   2 Mbyte of on-board SRAM
                   512 Kbytes FLASH Boot/Downloader

Real Time Clock: A Semtech SH3000 support IC provides a full BCD clock calender with programmable periodic/wakeup interrupt and a programmable clock generator with adjustable spectrum spreading.

Connectors: (see Table 4-1 and referenced Tables)

Table 4-1 - CPU Board Connector Summary

Ref.	# Pins	Function	Notes
P1	76-pin	Factory Debug Connector	
P2	36-pin	IOBUS Connector	
P3	44-pin	SCM Connector	
J3	9-pin	COM1 (RS-232) 9-pin male D-sub	see Figure 4-1 & Table 4-2
J4	9-pin	COM2 (RS-232) 9-pin male D-sub	see Figure 4-1 & Table 4-2
J5	9-pin	COM3 RJ-45 (RS-485)	see Figure 4-1 & Table 4-2
J2	10-pin	PLD JTAG Header	Not user accessible

4.2 COMMUNICATION PORTS

Connector/Port: J3 - 9-Pin D-Type - COM1 (RS-232) (on CPU Bd.)
                   J4 - 9-Pin D-Type - COM2 (RS-232) (on CPU Bd.)
                   J5 - 9-Pin D-Type - COM3 (RS-485) (on CPU Bd.)
                   J1 - 9-Pin D-Type - COM4 (RS-232) (on ECOM1 Bd.)
                   J2 - 9-Pin D-Type - COM5 (RS-485) (on ECOM1 Bd.)
                                     - COM6 Radio (on ECOM1 Bd.)*
                   J8 - 6-Pin RJ-45 - COM7 PSTN Modem (on ECOM1 Bd.)*
                   J1 - 9-Pin D-Type - COM8 (RS-232) (on ECOM2 Bd.)
                   J2 - 9-Pin D-Type - COM9 (RS-485) (on ECOM2 Bd.)
                                     - COM10 Radio (on ECOM2 Bd.)*
                   J8 - 6-Pin RJ-45 - COM11 PSTN Modem (on ECOM2)*
                   Note: * = available as an option

Baud Rate: 300 to 115Kbps for RS-232 or RS-485
                   Up to 56Kbps for Modem

                   Bottom of Enclosure (one or the other)
                   9-Pin D-Type - COM1 (RS-232)
                   3-Pin Circular - COM1 (RS-232)

Table 4-2 - RS-232 Ports (COM1/2/4/8 and RS-485 Ports COM3//5/9 Connector Pin Assignments

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	RXD	Receive Data Input	RXD-	Receive Data - Input
3	TXD	Transmit Data Output	TXD-	Transmit Data - Output
4	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Output
5	GND	Signal/Power Ground	ISOGND	Isolated Ground
6	DSR	Data Set Ready Input	RXD+	Receive Data + Input
7	RTS	Request To Send Output		N/A
8	CTS	Clear To Send Input		N/A
9		N/A		N/A

Looking into Bd. Receptacle
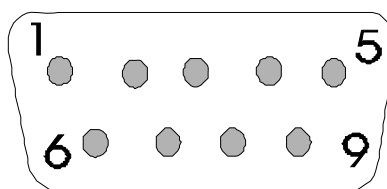
**Figure 4-1 - DB9 9-Pin Connector
Associated with COM1, COM2, COM3, COM4, COM5, COM8 & COM9**

4.3 SYSTEM CONTROLLER MODULE

4.3.1 Input Power Specs.
Note: Voltages are dc unless otherwise specified.

Operating Range:	+4.5/4.9V to +16.0V (+6V Input Supply) (Shutdown occurs at +4.72/4.33V nominal)
	+9.6/10.3V to +16.0V (+12V Input Supply) (Shutdown occurs at +10.29/9.56V nominal)
Output Voltages:	+3.3Vdc ±1%
Output Current:	1A Max. @ 3.3Vdc
Output Ripple P/P:	+3.3V Output: 10mV
Input Current:	*With Supply Loading of 3.3V @ 1.0A*
	Vin @ +6V - Iin Max. TBDA
	Vin @ +12V - Iin Max. TBDA
Fusing:	1A Slow Blow 5x20mm Fuse
Electrical Isolation:	None
Surge Suppression:	16V Transorb to DGND and Chassis
	Meets ANSI/IEEE C37.90-1978
Terminations:	Pluggable, maximum wire size is 16 gauge

Shutdown: +6V System:
                               Max. ON Switchpoint = 4.90V
                               Min. OFF Switchpoint = 4.33V

                               +12V System:
                               Max. ON Switchpoint = 10.3V
                               Min. OFF Switchpoint = 9.28V

4.3.2 Power Supply Sequencer Specs.

Signals Monitored: Input Power

Sequencer Switchpoints: +3.3V Max. ON Switchpoint = +3.15V
                               +3.3V Min. OFF Switchpoint = +3.00V
                               +1.8V Max. ON Switchpoint = +1.72V
                               +1.8V Min. OFF Switchpoint = +1.64V

Sequencer Output Signals: PFDLYCLK Timing on power down 2msec after POWER-
                               FAIL
                               VIN100M timing on power Up 1200msec delay for Good
                               Power
                               POWERGOOD incoming power, 3.3V & 1.8V in Spec.

4.3.3 Power Supply External Power Monitor Specs.

Input Signal: Input power after fuse, before Diode

Input Range: 0Vdc to 16Vdc

Resolution: 17 Bit

Accuracy: Uncalibrated: ±3% @ +25°C (+77°F)
                               Uncalibrated: ±4% over -40 to +85°C (-6.2 to +185°F)
                               Calibrated: ±0.1% @ +25°C (+77°F)
                               Calibrated: ±1.1% over -40 to +85°C (-6.2 to +185°F)

4.3.4 System Controller Module Connectors (see Figure 4-2, Tables 4-3 & 4-4)

Table 4-3 - System Controller Module Connector Summary

Ref.	# Pins	Function
P1	44-pin	Backplane Connector
P2	8-pin	MVT Interface Connector
TB1	3-pin	Input Power Term. Block (see Table 4-4)
TB2	3-pin	RTD Intf. Connector (see Section 2.3.5)
J2	8-pin	Display/Keypad Intf. Connector (RJ-45)

Table 4-4 - System Controller Module Input Power Terminal Block Assignments

TERM. #	NAME	FUNCTION
TB1-1	+VIN	+6Vdc or +12Vdc (nominal) Input
TB1-2	-VIN	Supply Common
TB1-3	CHASSIS	Chassis Ground

Bulk Supply #1 Pos. Term. ━━━━ ▣ ⊘1 **+VIN**
Bulk Supply #1 Neg. Term. ━━━━ ▣ ⊘ **-VIN**
Chassis Ground ━━━━ ▣ ⊘3 **CHASSIS**
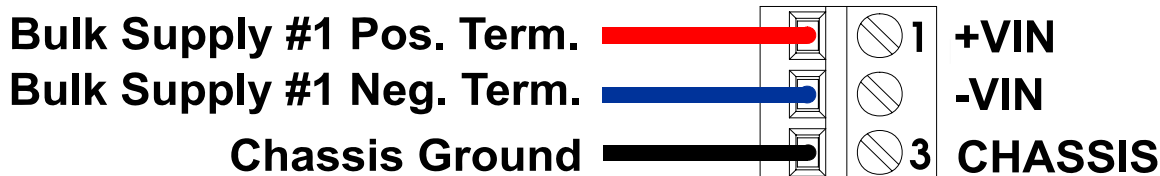
Figure 4-2 - SCM - TB1 (Power Connector)

4.4 INPUT/OUTPUT MODULE SPECIFICATIONS

4.4.1 Non-isolated Analog Input/Output Module

Non-isolated Analog Inputs

Number of Inputs:	6 Single Ended Inputs (1-5V or 4-20Ma) individually jumper configurable
Input Type:	(Externally Powered) Voltage Input: 1-5 Vdc (Externally Powered) Current Loop: 4-20mA
Input Impedance:	1 Meg ohm for 1-5V inputs 250 ohm for 4-20mA inputs

Non-isolated Analog Outputs

Number of Outputs:	2 AOs (1-5V or 4-20Ma) individually jumper configurable
4-20mA Output Compliance:	250 ohm load with 11V External Power Source 650 ohm load with 24V External Power Source
1-5V Output:	5mA maximum output current into external load with external voltage range of 11 to 30 Vdc

General AI/AO Module Specs.

Accuracy:	Analog Input 0.1% of Span @ +25ºC (+77ºF) 0.2% of Span @ -40ºC to +70ºC (-40ºF to 158ºF) Analog Output Current Output: 0.1% of Span @ +25ºC (+77ºF) 0.2% of Span @ -20ºC to +70ºC (-4ºF to 158ºF) 0.3% of Span @ -40ºC to +70ºC (-40ºF to 158ºF) Voltage Output Compliance ($I_{load}max$ = 5mA): (see Note[1] & Note[2]) 0.1% of Span + X @ +25ºC (+77ºF) 0.2% of Span + X @ -20ºC to +70ºC (-4ºF to +158ºF) 0.3% of Span + X @ -40ºC to +70ºC (-40ºF to 158ºF) where X = [(2.5 ohms x I_{load})/4.4V x 100] **Note[1]: Does not include error due to inductors**

Terminations: Pluggable - Max. wire size is 14 gauge

Data Transfer: 8 Bit Wide bus access

4.4.2 Non-isolated Digital Input/Output Module

<u>Non-isolated Digital Inputs</u>

Number of Inputs: 12 DI individually jumper configurable for 2mA or 60uA Internally Sourced (Dry Contact) operation

Input Filtering: 15 milliseconds

Input Current: Jumper configured for 2mA or 60uA nominal

'0' State Voltage: below 1.5V

'1' State Voltage: above 1.5V

Bus Access: Eight Bits Wide

Electrical Isolation: None

Surge Suppression: 31V Transorb between signal and ground
                           Meets ANSI/IEEE C37.90-1978

Status Indication: 12 LEDs (one per point)

<u>Non-isolated Digital Outputs</u>

Number of Outputs: 4 DO

Output Configuration: Open Drain (Externally Powered)

Maximum Load Current: 100mA @ 31Vdc

Bus Access: Eight Bits Wide

Electrical Isolation: None

Surge Suppression: 31V Transorb between signal and ground
                           Meets ANSI/IEEE C37.90-1978

<u>General DI/DO Module Specs.</u>

Power Consumption: <u>Status LEDs Disabled</u>
                           1.3mA @ 3.3Vdc: 12DIs OFF, CLK stopped
                           2.1mA @ 3.3Vdc: 12DIs ON @ 66uA, CLK stopped
                           25.3 @ 3.3Vdc: 12DIs ON @ 2mA, CLK stopped
                           3.6mA @ 3.3Vdc: 12DIs OFF, CLK active

4.4mA @ 3.3Vdc: 12 DIs ON @ 66uA, CLK active
27.6mA @ 3.3Vdc: 12 DIs ON @ 2mA, CLK active

<u>Status LEDs Enabled</u>
All DIs and DOs OFF: 33uA
All DIs and DOs ON: add 32mA

Terminations: Pluggable, max wire size is 14 gauge for local terminations - Two 14-pin mass termination headers are provided for remote terminations

4.4.3 Non-isolated High Speed Counter Input Module

Number of Inputs: 4 HSC Inputs per Module

Input Configuration: Internally Sourced Dry Contact, individually Jumper selectable Debounce Circuitry and individually Jumper selectable input current of 200uA or 2mA

Input Frequency: 10kHz Max.

Input filtering: 20 microseconds

Signal Conditioning: Debounce circuit for contact closures and bandwidth limiting

'1' State Voltage: below 1.5V
'0' State Voltage: above 1.5V

Bus Access: Eight Bits Wide

Electrical isolation: None

Surge Suppression: 31V Transorb between signal and ground
Meets ANSI/IEEE C37.90-1978

Terminations: Pluggable, max wire size is 14 gauge for local terminations - Two 14-pin mass termination headers are provided for remote terminations

Status Indication: 4 LEDs (one per point)

Power Consumption: 3.9mA IOCLK stopped (All Inputs OFF)
6.8mA IOCLK running (All Inputs OFF)
<u>Additional Current per Input</u>
200uA or 2MA per HSCSET or HSCRST Input (ON State)
2mA per ON LED
33uA for LED circuitry

4.4.4 Non-isolated Mixed Input/Output Module

Number of I/Os: 6 jumper configurable DI/DOs per Module
4 Analog Inputs per Module

2 High Speed Counter Inputs per Module
1 Analog Output (optional) per Module

Terminations: Pluggable - Max. wire size is 14 gauge

Power Consumption: 5mA Base Current @ 3.3V

Non-isolated Mixed I/O Module Digital Inputs/Outputs

Number of Points: Up to 6 individually jumper configurable DI/O

Input Current: Individually Jumper selectable input current of 60uA or 2mA

Input Configuration: Internally Sourced Dry Contact

Input Filtering: 30 milliseconds

'0' State Voltage: below 1.5V

'1' State Voltage: above 1.5V

Bus Access: Eight Bits Wide

Surge Suppression: 31V Transorb between signal and ground
Meets ANSI/IEEE C37.90-1978

Status Indication: None

Output Configuration: Open Drain (Externally Powered)

Max. DO Load Current: 100mA @ 31Vdc

Electrical Isolation: None

Power Consumption: Add: 66uA or 2mA for Each ON DI (Jumper Selectable per Point)

Non-isolated Mixed I/O Module Analog Inputs

Number of Inputs: 4 Single Ended Inputs (1-5V or 4-20Ma) individually jumper configurable

Input Type: (Externally Powered) Voltage Input: 1-5 Vdc
(Externally Powered) Current Loop: 4-20mA

Input Impedance: 1 Meg ohm for 1-5V inputs
250 ohm for 4-20mA inputs

Accuracy: 0.1% of Span @ +25ºC (+77ºF)
0.2% of Span @ -40ºC to +70ºC (-40ºF to 158ºF)

Conversion Time: 20 microseconds

| Power Consumption: | 2.5mA + 1.145mA @ 4.66US/Channel Period, CLK active |
| | 180uA, CLK stopped |

Non-isolated Mixed I/O Module Analog Output

| Number of Outputs: | 1 AO (1-5V or 4-20Ma) jumper configurable |

4-20mA Output
Compliance:

250 ohm load with 11V External Power Source
650 ohm load with 24V External Power Source

1-5V Output:

5mA maximum output current into external load with external voltage range of 11 to 30 Vdc

Accuracy:

Current Output:
0.1% of Span @ +25ºC (+77ºF)
0.2% of Span @ -20ºC to +70ºC (-4ºF to 158ºF)
0.3% of Span @ -40ºC to +70ºC (-40ºF to 158ºF)

Voltage Output Compliance ($I_{load}max$ = 5mA):
  (see Note[1] & Note[2])
0.1% of Span + X @ +25ºC (+77ºF)
0.2% of Span + X @ -20ºC to +70ºC (-4ºF to +158ºF)
0.3% of Span + X @ -40ºC to +70ºC (-40ºF to 158ºF)

where X = [(2.5 ohms x I_{load})/4.4V x 100]
Note[1]: Does not include error due to inductors
Note[2]: 2.5 ohm uncompensated series resistance with
       Inductors

Power Consumption:

System Power - 5.0mA from 3.3V source
External Power V to I (AO at 20mA each) - 24.3mA
External Power V to I (AO at 5V @ 0mA) – 4.2mA
External Power V to I (AO at 5V @ 5mA) - 9.2mA

Non-isolated Mixed I/O Module High Speed Counter Inputs

| Number of Inputs: | 2 HSC Inputs per Module |

Input Configuration:

Internally Sourced Dry Contact, individually Jumper selectable Debounce Circuitry and individually Jumper selectable input current of 180uA or 2.2mA. HSC Circuitry can be Jumper Enable/Disabled to save power

| Input Frequency: | 10kHz Max. |

| Input filtering: | 20 microseconds |

Signal Conditioning:

Debounce circuit for contact closures and bandwidth limiting

| '1' State Voltage: | below 1.5V |
| '0' State Voltage: | above 1.5V |

| Bus Access: | Eight Bits Wide |

Electrical isolation:	None
Surge Suppression:	31V Transorb between signal and ground Meets ANSI/IEEE C37.90-1978
Status Indication:	None
Power Consumption:	200uA or 2mA per HSCSET or HSCRST Input (ON State) (Jumper Selectable per Point) (Clock Power Disabled - Subtract 1.1mA @ 3.3V)

4.5 DIGITAL TO RELAY I/O BOARD SPECIFICATIONS

Digital to Relay I/O Board General Specs.

Terminations:	Pluggable - Max. wire size is 14 gauge

Digital to Relay I/O Board Input Requirements

Power Source Range:	3 to 15 Vdc
SSR Input Impedance:	400 Ohms
MOSFET Sink Current:	Max. = 20mA (both SSRs in Normally Closed mode)

Digital to Relay I/O Board Output Requirements

Contact Ratings:	3 to 60 Vdc
Maximum Current:	3 Amps at 25°C (77°F) or 1.5 Amps at 70°C (158°F)
Maximum ON State:	1.2Vdc
Minimum Current Load:	100mA

4.6 21V POWER SUPPLY BOARD SPECIFICATIONS

21V Power Supply Board General Specs.

Terminations:	Pluggable - Max. wire size is 14 gauge
ESD Susceptibility:	Field connected circuits meet the requirements of IEC 801-2 for withstand capability up to 10KV.
EMI Compatibility:	Designed to coexist within a shielded enclosure with the **Control**Wave **EFM** electronics. EMI radiation is insignificant and susceptibility is comparable or superior to associated electronics.
Transient Susceptibility:	Field connected circuits meet the requirements of ANSI/IEEEC37.90-1998 (Formerly IEEE 472) for surge withstand capability.

Vibration:	1g for 10Hz to 500Hz per PMC-31-1 (without damage or impairment)

21V Power Supply Board Performance Specifications

Input Voltage (Vin):	10.8V to 16V (dc)
Input Current (Iin):	100mA (Typ. @ 12V & 50mA load) 140mA (Max. over Temp. Range @ 50mA load)
Output Voltage (Vout):	21.4Vdc ±0.8V
Output Current (Iout):	50mA (Max.)
Ripple/Noise:	20mV (Max. P-to-P)
Efficiency:	88% (Typ.)
Fuses:	F1 = 500mA (Slow Blow): Protects host power source from failures within the 21V Pwr. Supply Bd. F2 = 350mA(Fast Blow): Protects 21V Pwr. Supply Bd. circuitry from short circuits on an output.

4.7 ENVIRONMENTAL SPECIFICATIONS

Temperature:	Operating:	-40 to +158 °F (-40 to +70 °C)
	Storage:	-40 to +158 °F (-40 to +70 °C)

Relative Humidity:	0-95% Non-condensing
Vibration:	2g for 10 - 150 Hz 1g for 150 - 2000 Hz
RFI Susceptibility:	In conformity with the following standards: IEC 1000-4-3 (Level 2): 3V/meter - 80MHz to 1000MHz
ESD:	Field connected circuits meet the requirements of IEC 1000-4-2 for ESD withstand capability up to 4KV

4.8 DIMENSIONS

4-Slot Base Chassis:	see Figure 4-3
8-Slot Base Chassis:	see Figure 4-4
NEMA 3X Enclosure	see Figure 4-5

Top

2.34

Front

4.49

1.75   .50

.46 Dia.

.22

1   2   1   2   1   2
JP1
P3   P4   P5
35 36   35 36   35 36
JP2
36
JP3
1   2   1   2   1
P1   P2   P10
44 43   44   43
JP4

5.125

.438

Right Side

3.46

6.00
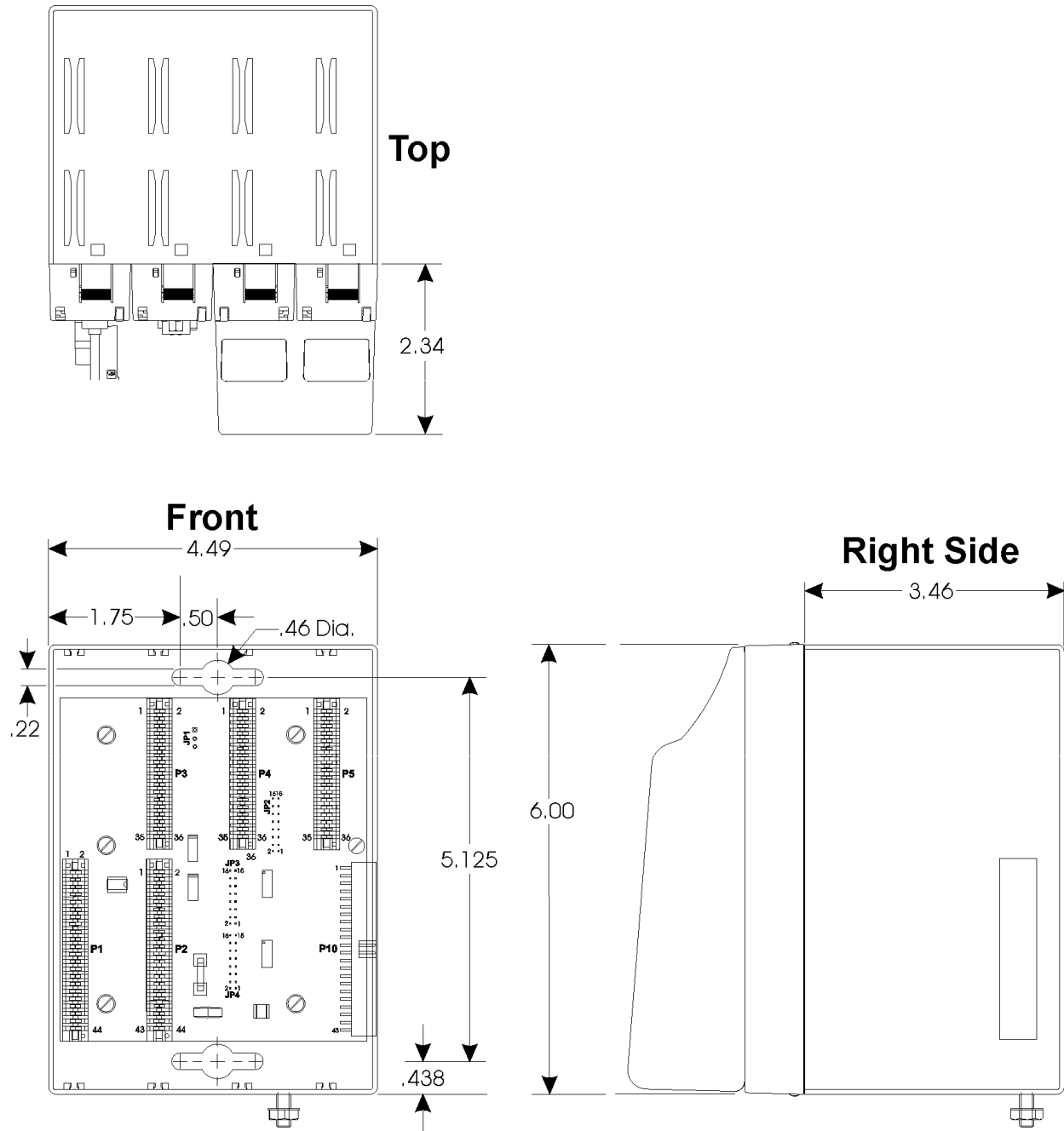
Figure 4-3 - 4-Slot ControlWave EFM
Base Chassis Assembly Dimensions

Right Side

3.46

6.00

Top

2.34

1 2 3 4 5 6 7 8

Front

5.125

.438

8.97

.46 Dia.

4.50

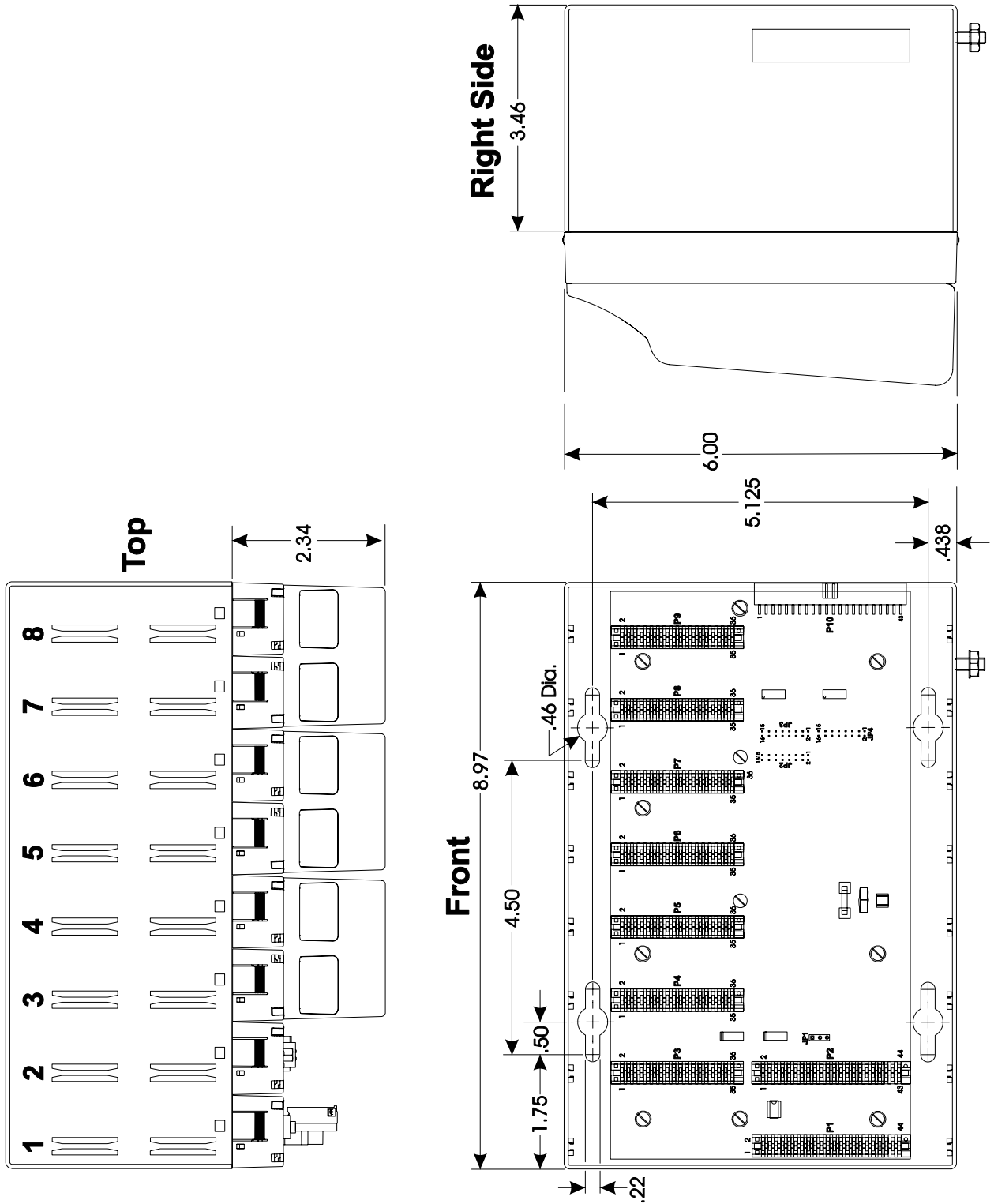.50

1.75

.22

P9
P10
P8
P7
P6
P5
P4
P3
P2
P1

**Figure 4-4 - 8-Slot ControlWave EFM
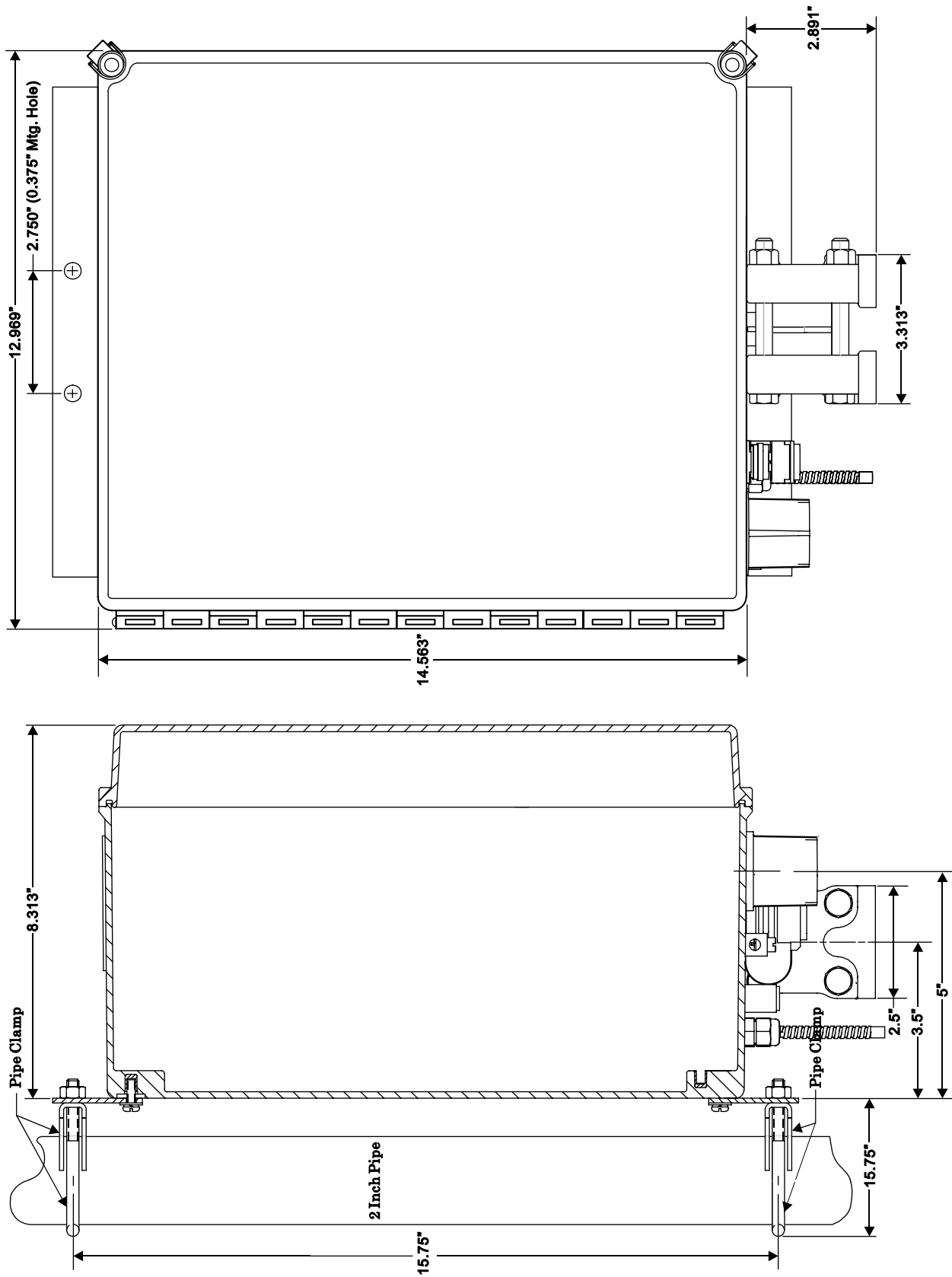Base Chassis Assembly Dimensions**

Figure 4-5 - Control Wave **EFM NEMA 3X Enclosure Dimensions**

ControlWave EFM
Special Instructions for Class I, Division 2 Hazardous Locations

1. Bristol, Inc.'s **Control**Wave **EFM** Electronic Flow Meter is listed by Underwriters Laboratories (UL) as nonincendive and is suitable for use in Class I, Division 2, Group C and D hazardous locations or nonhazardous locations only. Read this document carefully before installing a nonincendive **Control**Wave **EFM** Electronic Flow Meter. Refer to the **Control**Wave **EFMs** Electronic Flow Meter User's Manual for general information. In the event of a conflict between the **Control**Wave **EFM** Electronic Flow Meter User's Manual and this document, always follow the instructions in this document.

2. The **Control**Wave **EFM** Electronic Flow Meter includes both nonincendive and unrated field circuits. Unless a circuit is specifically identified in this document as nonincendive, the circuit is unrated. Unrated circuits must be wired using Div. 2 wiring methods as specified in article 501-4(b) of the National Electrical Code (NEC), NFPA 70 for installations in the United States, or as specified in Section 18-152 of the Canadian Electrical Code for installation in Canada.

3. The local communications port terminates in a D-Type connector on the bottom of the **Control**Wave **EFM** Electronic Flow Meter enclosure. The wiring on this connector is unrated. No connections may be made to this port unless the user ensures that the area is known to be nonhazardous. Connections to this port are temporary, and must be short in duration to ensure that flammable concentrations do not accumulate while it is in use.

4. The optional power system (solar panel and battery) approved for use with the nonincendive **Control**Wave **EFM** Electronic Flow Meter are described in the Model Specification. The connection to the solar panel is approved as a nonincendive circuit so that Division 2 wiring methods are not required. The nominal panel voltage must match the nominal battery voltage (12V).

5. **WARNING: EXPLOSION HAZARD - Do Not disconnect Solar Power from the Battery or any other power connections within the Control**Wave **EFM Enclosure (including con-nectors TB1 through TB6 on the Power Distribution Board, connector TB1 on the System Controller Module, any power connections to optional items such as radio, modem, Digital to Relay I/O Board, 21V Power Supply Board, or cabling to the Display/Keypad unless the area is known to be nonhazardous.**

6. **WARNING: EXPLOSION HAZARD - Substitution of major components may impair suitability for use in Class I, Division 2 environments.**

7. **WARNING: EXPLOSION HAZARD - The area must be known to be nonhazardous before servicing/replacing the unit and before installing or removing I/O wiring.**

8. **WARNING: EXPLOSION HAZARD - Do Not disconnect equipment unless power has been disconnected and the area is known to be nonhazardous.**

9. An RTD is normally supplied with the **Control**Wave **EFM**. Connection to the RTD is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.

10. Signal connectors available for customer wiring are listed in Table A1. I/O Connections are unrated and must be wired using Div. 2 wiring methods.

11. The UL listed nonincendive **Control**Wave **EFM** may include radio/modem communications (listed on Model Spec.) that is used in conjunction with a 30W Solar Panel and 12V, 33AH Lead Acid Battery System. Connection to the radio or modem is approved as a nonincendive circuit, so that Division 2 wiring methods are not required.

12. The UL Listed nonincendive **Control**Wave **EFM** may include a Digital To Relay I/O Board (option). No field wiring connections/removals should be made at the Digital To Relay I/O Board unless the area is known to be nonhazardous. Digital To Relay I/O Board I/O circuitry is unrated and must be wired using Div. 2 wiring methods.

13. The UL Listed nonincendive **Control**Wave **EFM** may include a 21V Power Supply Board (option). No field wiring connections/removals should be made at the 21V Power Supply Board unless the area is known to be nonhazardous**.** 21V Power Supply Board Transmitter Interface circuitry is unrated and must be wired using Div. 2 wiring methods.

Table A1 –Module/Board Connector Customer Wiring Connectors

Module/Item	Connector	Wiring Notes
CPU Module	J3 - COM1, 9-pin Male D-sub	Factory Connected to Local Comm. Port. Refer to ¶ 3 of this document.
CPU Module	J4 - COM2, 9-pin Male D-sub RS-232 J5 - COM3, 9-pin Male D-sub RS-485	Remote Comm. Port: For Radio or external Network Comm. Refer to Model Spec. and ¶ 10 of this document. When used for Network Comm., use Div. 2 wiring methods. If COM2 is used in conjunction with a radio/modem refer to 11 of this document.
SCM Module	J2 - Display Intf. RJ-45 Female	Factory Wired - *
SCM Module	P2 - MVT Intf.	Factory Wired - *

ControlWave EFM
Special Instructions for Class I, Division 2 Hazardous Locations
Table A1 -Module/Board Connector Customer Wiring Connectors (Continued)

Module/Item	Connector	Wiring Notes
SCM Module	TB1 - Input Power	Typically Factory Wired - *
SCM Module	TB2 - RTD Interface	Field Wired - Refer to ¶ 9 of this document.
Exp. Comm Module 1	J4 - COM4, 9-pin Male D-sub RS-232 J5 - COM5, 9-pin Male D-sub RS-485	Remote Comm. Port: For Radio or external Network Comm. Refer to Model Spec. and ¶ 10 of this document. When used for Network Comm., use Div. 2 wiring methods. If COM4 is used in conjunction with a radio/modem refer to 11 of this document.
Exp. Comm Module 1	J8 - COM7, RJ11 Female	Modular connection to Phone Co. equipment.
Exp. Comm Module 2	J4 - COM8, 9-pin Male D-sub RS-232 J5 - COM9, 9-pin Male D-sub RS-485	Remote Comm. Port: For Radio or external Network Comm. Refer to Model Spec. and ¶ 10 of this document. When used for Network Comm., use Div. 2 wiring methods. If COM8 is used in conjunction with a radio/modem refer to 11 of this Document.
Exp. Comm Module 2	J8 - COM11, RJ11 Female	Modular connection to Phone Co. equipment. Refer to ¶ 6, 7, 8 & 11of this document.
Analog I/O Module	TB1/TB2 - 10-pin Term. Blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods. *
Digital I/O Module	TB1/TB2 - 10-pin Term. Blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods. *
HSC Input Module	TB1/TB2 - 10-pin Term. Blocks	Field Input wiring connectors are unrated; use Div. 2 wiring methods. *
Mixed I/O Module	TB1/TB2 - 10-pin Term. Blocks	Field I/O wiring connectors are unrated; use Div. 2 wiring methods. *
Digital To Relay I/O Bd.	J1 10-pin In-line Connector	Field I/O wiring connector is unrated, use Div. 2 wiring methods. Refer to ¶ 12 of this document. *
Power Distribution Bd. (see ¶ 5 - this document)	TB1 - 3-pin Term Block TB2 - 2-pin Term Block TB3 - 2-pin Term Block TB4 - 2-pin Term Block TB5 - 2-pin Term Block TB6 - 2-pin Term Block	Primary Power Input - User wired * Main Power Out 1 - Factory wired * Main Power Out 2 - Factory wired * Fused Power Out 1 - Factory wired * Fused Power Out 2 - Factory wired * Fused Power Out 3 - Factory wired *
21V Power Supply Bd. (see ¶ 5 & 13 of this document)	TB1 - 3-pin Term Block TB2 - 4-pin Term Block	12V Power Input - Factory wired * 21V Transmitter Power -Field Wired TB2 is unrated, use Div. 2 wiring methods.
Enclosure Bottom	Local Port Circular Connector	Local Comm. Port - Factory Wired. Refer to ¶ 3 of this document. *

*Note: * = These wires should only be installed/removed when the item (PCB) in question is installed/removed or when checking wiring continuity. The area must be known to be nonhazardous before servicing/replacing the unit and before installing or removing PCBs, Connectors or individual I/O or Power wires. Refer to ¶ 6, 7 & 8 of this document. All input power and I/O wiring must be performed in accordance with Class I, Division 2 wiring methods as defined in Article 501-4 (b) of the National Electrical Code, NFPA 70, for installations within the United States, or as specified in Section 18-152 of the Canadian Electrical Code for installation in Canada.*

Appendix C
HARDWARE INSTALLATION GUIDE

Hardware Configuration

There are seven (7) main steps required to configure a **Control**Wave **EFM**. This appendix provides an overview of these steps with an emphasis on the installation and configuration of the hardware. This appendix is intended for users who have already installed at least one **Control**Wave **EFM**.
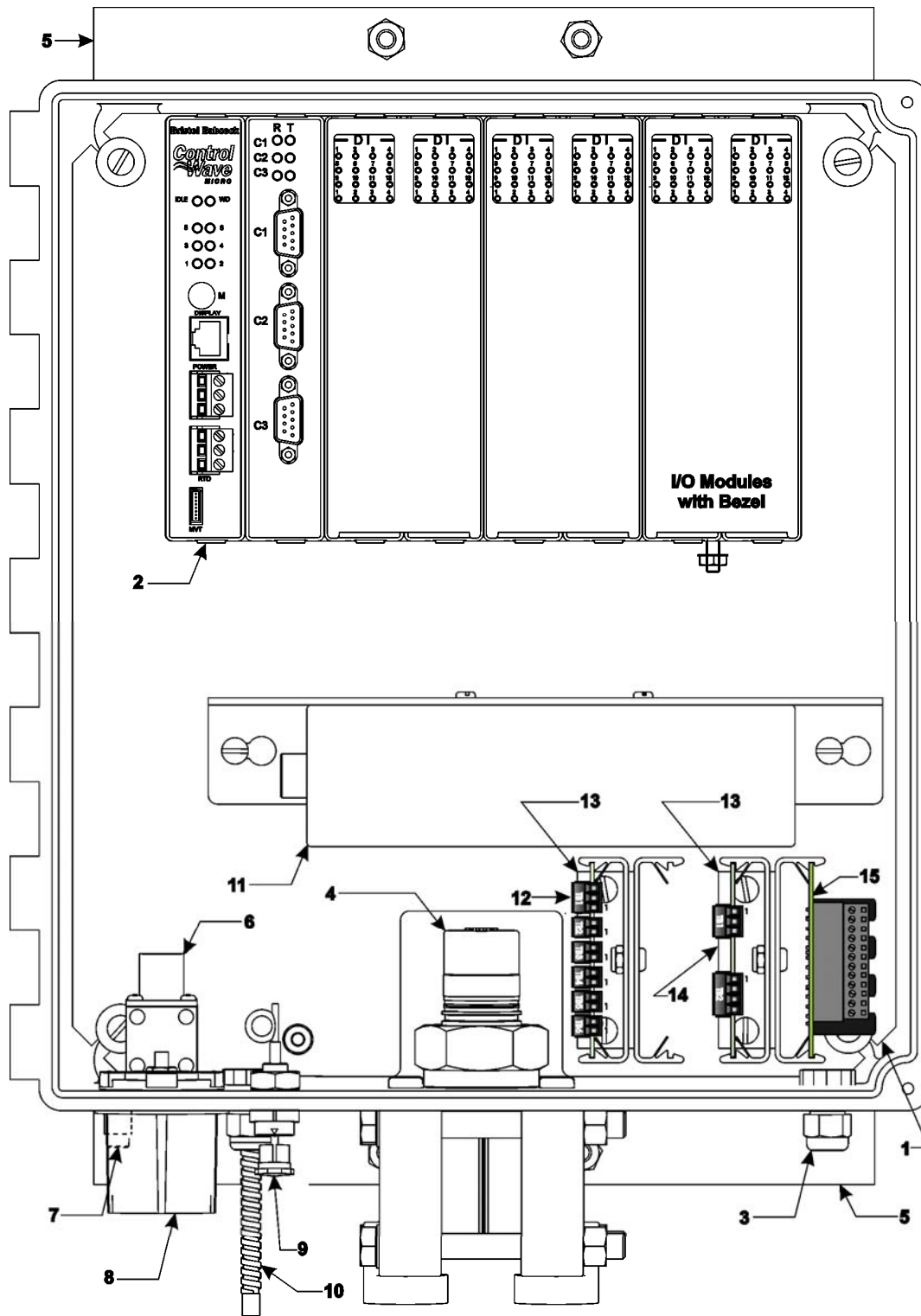
Step 1. Hardware Configuration

This involves unpacking the **Control**Wave **EFM** hardware, mounting the chassis, installing I/O modules, wiring I/O terminations, making proper ground connections, connecting a communication cable to the PC workstation and setting switches. To install and configure the **Control**Wave **EFM**, follow Hardware Configuration steps 1 through 11 below:

1. Remove the unit from its carton and install it at the assigned work site (see Section 2.3.1). Dimensions are provided in Section 4.6 of this manual.
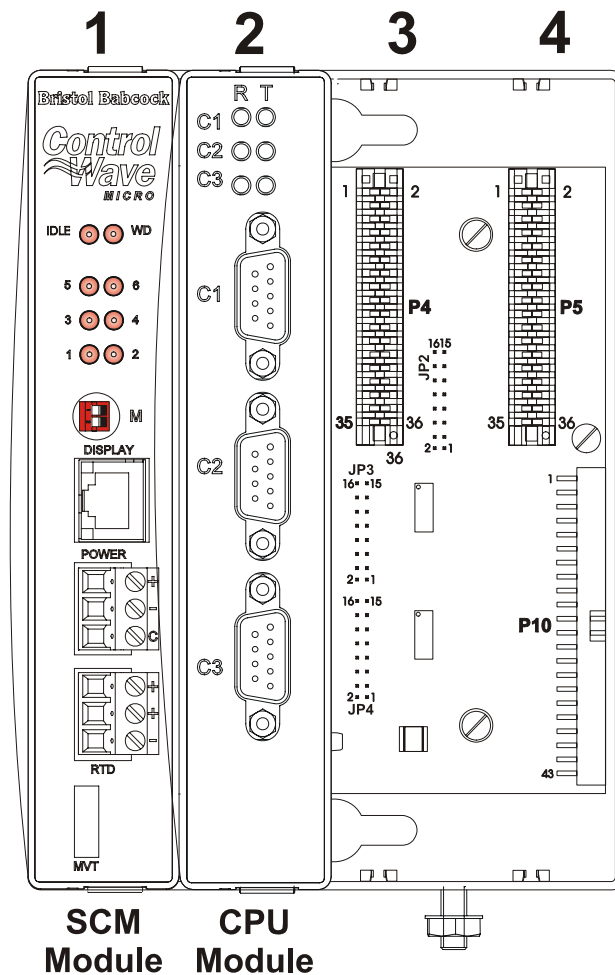
Figure C-1A - Control Wave **EFM - Base Assembly Chassis
SCM & CPUM Installed in Slots #1 & #2 (Respectively)**

1. Fabrication Panel
2. ControlWave MICRO EFM 8-Slot Base Assembly
   (from Left to Right - SCM, CPU & 6 I/O Modules)
3. .5" Liquid Tight Conduit Fitting
4. Multivariable Transducer (MVT)
5. Rear Pipe Mounting Bracket (Qty. 2)
6. Optional Polyphaser
7. Ground Lug (Behind Item #8)
8. 1" NPT Conduit Hub

9. Local Comm. Port Connector
10. RTD Probe (Conduit)
11. External Radio (MDS - Transnet)
12. Power Distribution Board
13. Dual PCB Mounting Bracket
    (with Snap Tracks))(Qty. 2)
14. 21V Power Supply Board
15. Digital to Relay I/O Board

Figure C-1B - 8-Slot ControlWave EFM (Internal View)
SCM & CPUM Installed in Slots #1 & #2 (Respectively) of Base Assembly

Step 1. Hardware Configuration (Continued)

2. Remove the System Controller Module (SCM) and after configuring its configuration jumpers, install it in chassis slot 1, i.e., the first slot from the left end of the Base Assembly Chassis (see Section 2.3.2).
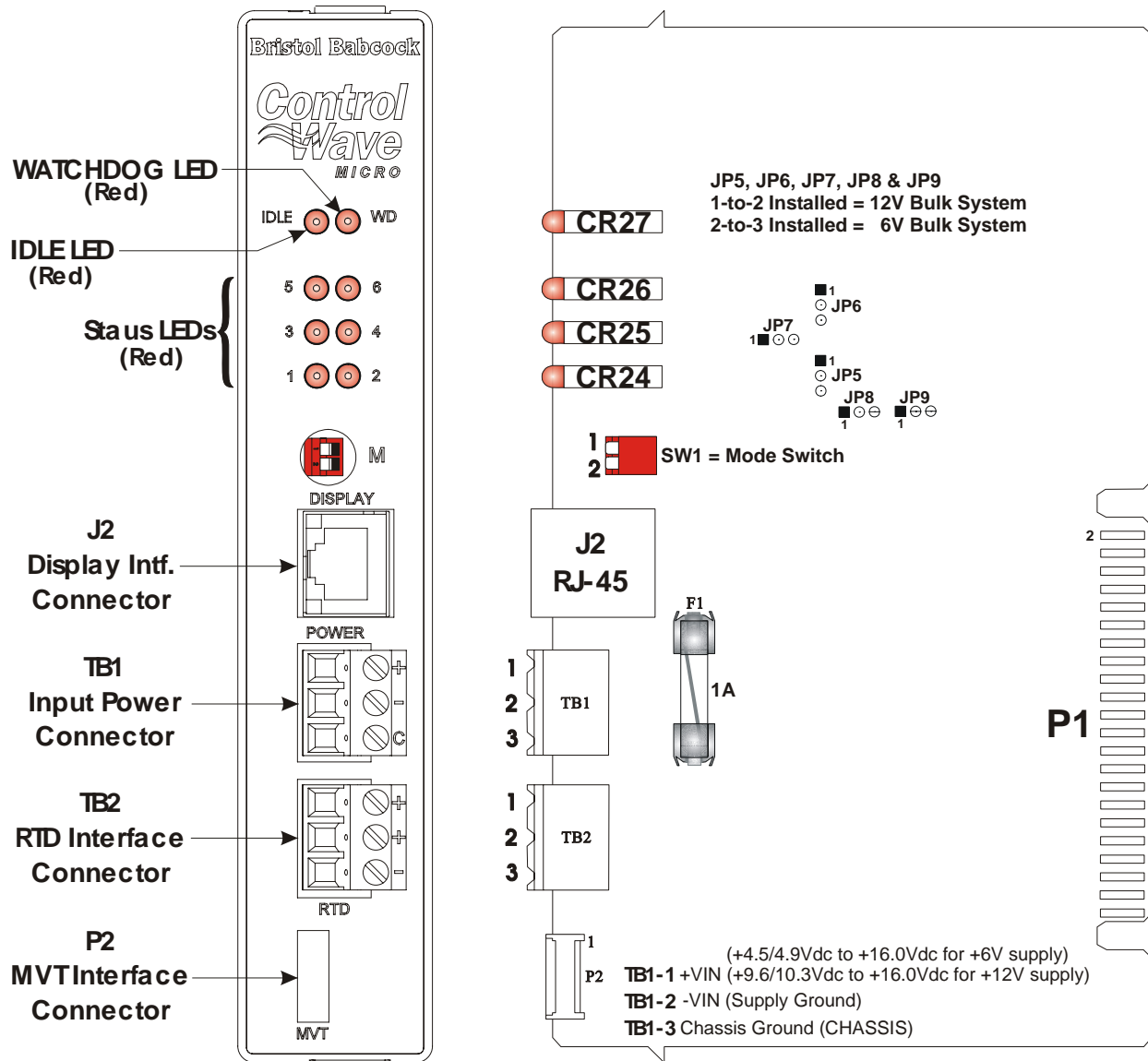
Figure C-2 - SCM Component Identification and TB1 Wiring Diagram

3. Remove the CPU Module. Make sure that the Lithium Backup Battery has been enabled, i.e., Backup Battery Board Jumper JP1 should be installed (on its jumper posts). After configuring the CPU Module's DIP-Switches (see Section 2.3.3), install it into **Control**Wave **EFM** Base Assembly, chassis slot 2, i.e., the second slot from the left end of the Base Assembly Chassis. Tables C-1, C-2 and C-3 provide an overview of switch settings (see Tables C-1, C-2, C-3 and Figure C-3).

Table C-1 - CPU Bd. Switch SW1 - Force Recovery Mode/Battery Enable

Switch	Function	Setting - (OFF = Factory Default)
SW1-3	Force Recovery Mode	ON = Force recovery mode (via CW Console) OFF = Recovery mode disabled

Note: SCM Switch SW1 can also be used for Force Recovery Mode operation

Table C-2 - CPU Bd. Switch SW2 - User Configurations
Note: Except for SW2-4, ON = Factory Default

Switch	Function	Setting - (ON = Factory Default)
SW2-1	Watchdog Enable	ON = Watchdog circuit is enabled OFF = Watchdog circuit is disabled
SW2-2	Lock/Unlock Soft Switches	ON = Write to Soft Switches and FLASH files OFF = Soft Switches, configurations and FLASH files are locked
SW2-3	Use/Ignore Soft Switches	ON = Use Soft Switches (configured in FLASH) OFF = Ignore Soft Switch Configuration and use factory defaults
SW2-4	Core Updump See Section 3.6	ON = Core Updump Disabled OFF = Core Updump via Mode Switch (SW1) on SCM
SW2-5	SRAM Control	ON = Retain values in SRAM during restarts OFF = Force system to reinitialize SRAM
SW2-6	System Firmware Load Control *	ON = Enable remote download of System Firmware OFF = Disable remote download of System Firmware
SW2-8	Enable WINDIAG	ON = Normal Operation (don't allow WINDIAG to run test) OFF = Disable boot project (allow WINDIAG to run test)

* = Boot PROM version 4.7 or higher and System PROM version 4.7 or higher

Table C-3 provides CPU Switch SW3 (COM3) and ECOM Switch SW1 COM5/9 RS-485 communication port settings.

Table C-3 - CPU Bd. Switch SW3 for COM3 & ECOM Bd. Switch SW1 for COM5/9 Loopback & Termination Control

Switch #	RS-485 Function Switch ON	Setting
1	TX+ to RX+ Loopback	ON - Only for Diagnostics
2	TX- to RX- Loopback	ON - Only for Diagnostics
3	100 Ohm RX+ Termination	ON - End Nodes Only
4	100 Ohm RX- Termination	ON - End Nodes Only
5	N/A	ON - Slew Rate Enabled
6 (see note 2)	Slow Slew Rate ISO485 ONLY	ON - Slow Rate Enabled OFF - Fast Rate Enabled
7	RX+ Bias (End Node)	ON - End Nodes Only
8	RX- Bias (End Node)	ON - End Nodes Only

Note 1: Closed = Switch set ON
Note 2: Switch SW3 (COM3) = N/A

Step 1. Hardware Configuration (Continued)

4. Configure/Connect appropriate communication port(s) (see Sections 2.3.3.2). Connect COMM. Port 1 or 2 of the **Control**Wave **EFM** (depending on CPU Switch SW1 settings - see Tables C-2 & C-3) to a Communication Port of a PC (typically PC COMM. Port 1). *Note: Also see Section 2.4.4.*

A **Control**Wave **EFM** can be configured as a Master or Slave node on either a MODBUS network or a BSAP network. Up to three communication ports are contained on the **Control**Wave **EFM** CPU Module and are designated as follows:

CPU Module:
COM1 - Port 1:   CPU Bd. J3, PC/AT 9-Pin Male D-Sub - RS-232
COM2 - Port 2:   CPU Bd. J4, PC/AT 9-Pin Male D-Sub - RS-232
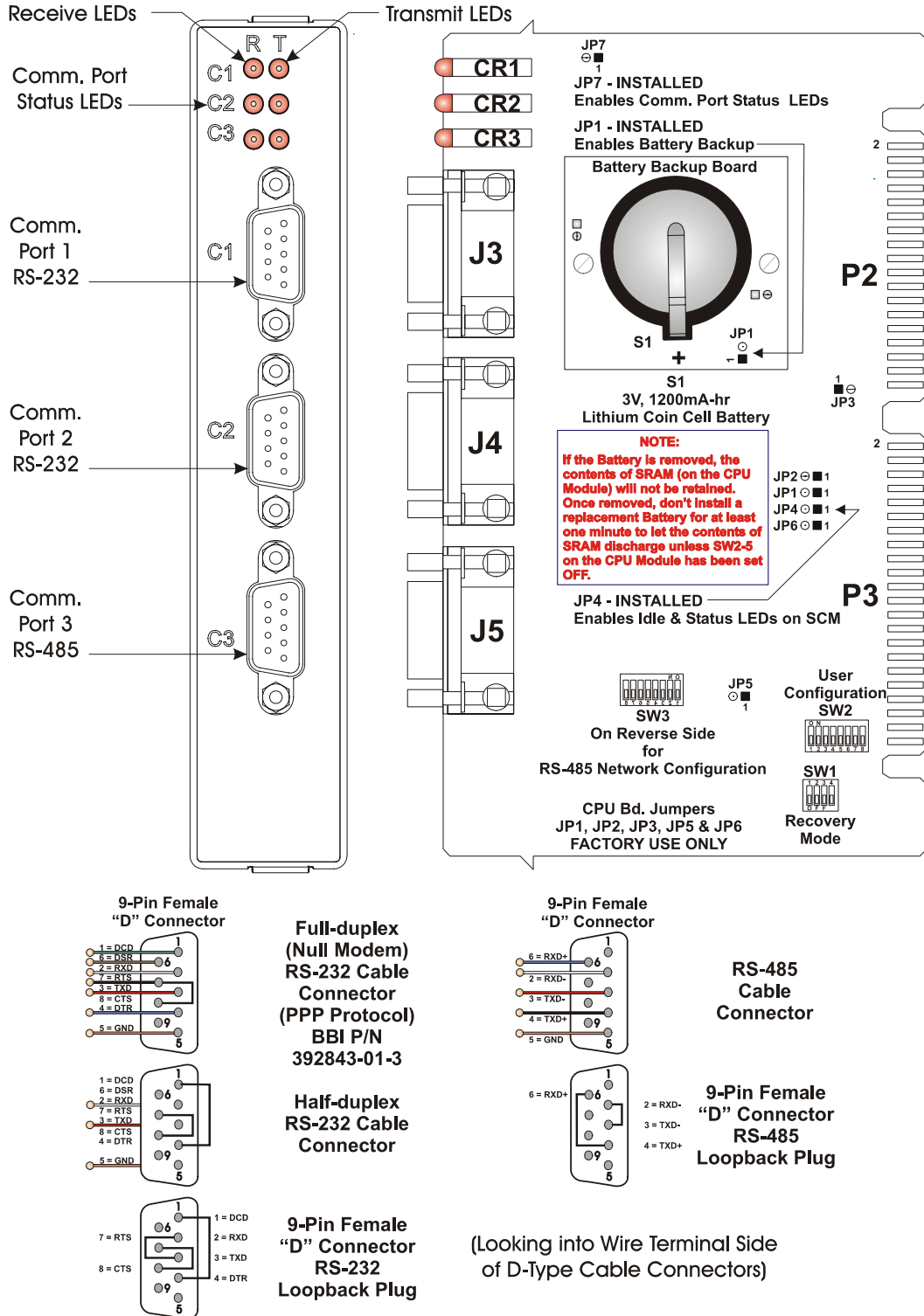COM3 - Port 3:   CPU Bd. J5, PC/AT 9-Pin Male D-Sub - RS-485 - Supported by SW3

Figure C-3 - CPU Module Component Identification Drawing

Expansion Communications Module:

COM4, COM5, COM6 & COM7 on 1st ECOM Bd., - assigned to Base Housing Slot #3

COM8, COM9, COM10 and COM11 on 2nd ECOM Bd., assigned to Base Housing Slot #4

COM4/8 -   Port 1: ECOM Bd. J1, PC/AT 9-Pin Male D-Sub - Both RS-232

COM5/9 -   Port 2: ECOM Bd. J2, PC/AT 9-Pin Male D-Sub - Both RS-485

COM6/10 - Port 3: ECOM Bd. Piggy-back Radio Module (FreeWave or MDS TransNet Spread Spectrum Modem) Antenna connector provided (**Optional**)

COM7/11 - Port 4: ECOM Bd. Piggy-back Modem Module (Multitech 56KB PL/PSTN Modem) RJ-11 connector provided (**Optional**)

Communication Ports COM1, COM2, COM3, COM4, COM5, COM8 and COM9 support serial asynchronous operation. Communication Ports COM1, COM2, COM4 and COM5 support RS-232 while COM3, COM5 and COM9 support RS-485 operation. Communication Ports COM4/8, COM5/9, COM6/10 and COM7/11 reside on optional Expansion Communications Modules (ECOM1/2). ECOM1 must reside in Base Chassis Backplane Slot #3 while ECOM2 must reside in Base Chassis Backplane Slot #4. ECOM Modules have one RS-232 Port and one RS-485 Port. Additionally, an ECOM Module may optionally contain a 56Kbaud PSTN Modem and/or a Spread Spectrum Modem (Radio). Any communication port can be configured for local communications, i.e., connected to a PC loaded with **Control**Wave Designer and OpenBSI software. The pin labels for the 9-pin, RS-232/485 interface are provided in Table C-4.

Table C-4 - RS-232 Ports COM1/2/4/8 and RS-485 Ports COM3/5/9 Connector Pin Assignments

Pin #	Signal RS-232	Description: RS-232 Signals	Signal RS-485	Description: RS-485 Signals
1	DCD	Data Carrier Detect Input		N/A
2	RXD	Receive Data Input	RXD-	Receive Data - Input
3	TXD	Transmit Data Output	TXD-	Transmit Data - Output
4	DTR	Data Terminal Ready Output	TXD+	Transmit Data + Output
5	GND	Signal/Power Ground	GND/ISOGND*	Ground/Isolated Ground*
6	DSR	Data Set Ready Input	RXD+	Receive Data + Input
7	RTS	Request To Send Output		N/A
8	CTS	Clear To Send Input		N/A
9		N/A		N/A

* ISOGND on Isolated RS-485 Ports Only!

Remove any Expansion Communication Module and configure its Jumpers as required (see Figures C-4A & C-4B). Install each Expansion Comm. Modules into the appropriate **Control**Wave **EFM** Base Housing Communication I/O Slot. Expansion Comm. Modules may reside in **Control**Wave **EFM** Base Housing Slots #3 and #4 ONLY (1st ECOM resides in Slot #3, 2nd ECOM resides in Slot #4). Expansion Comm. Modules may not reside in Expansion Housings.

Spread Spectrum Modem Port

An optional Spread Spectrum Modem (Radio) is available on each Expansion Communications Module (mounted piggy-back) and is assigned port status as follows: COM6 for ECOM1 and COM10 for ECOM2. There are two unique radios offered. These radios will only communicate with their own brand of radio, i.e., FreeWave radios are not compatible with MDS radios. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the radio at a rate up to 115.2kHz.

Radios are user installed onto the ECOM Module (see Figure C-4A) and their associated Ports are setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView.

FreeWave® Spread Spectrum Wireless Data Transceiver:
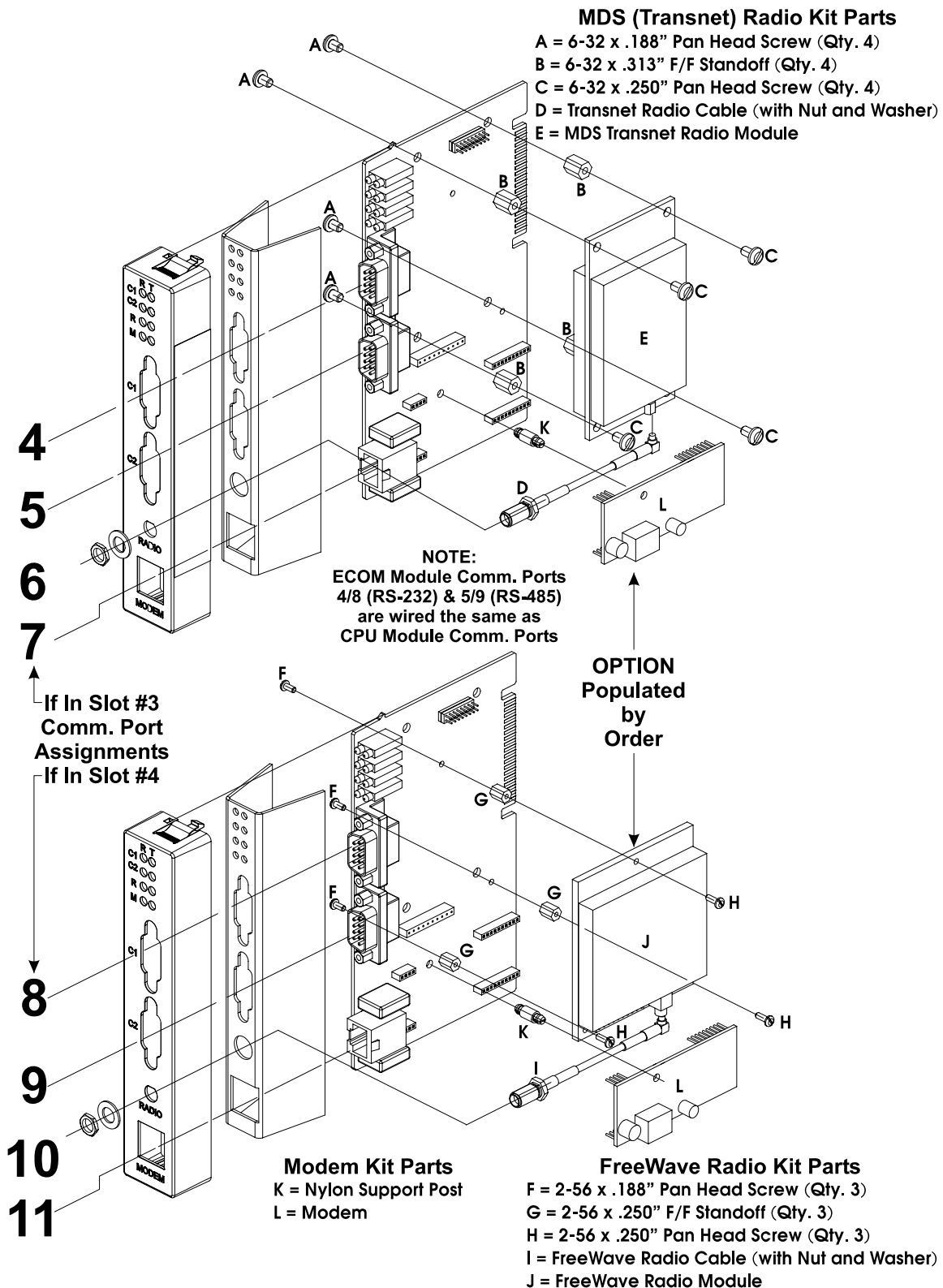Operates in the 902 to 928 MHz range (20 miles).

MDS (Transnet) Radio Kit Parts
A = 6-32 x .188" Pan Head Screw (Qty. 4)
B = 6-32 x .313" F/F Standoff (Qty. 4)
C = 6-32 x .250" Pan Head Screw (Qty. 4)
D = Transnet Radio Cable (with Nut and Washer)
E = MDS Transnet Radio Module

NOTE:
ECOM Module Comm. Ports
4/8 (RS-232) & 5/9 (RS-485)
are wired the same as
CPU Module Comm. Ports

**OPTION
Populated
by
Order**

If In Slot #3
Comm. Port
Assignments
If In Slot #4

Modem Kit Parts
K = Nylon Support Post
L = Modem

FreeWave Radio Kit Parts
F = 2-56 x .188" Pan Head Screw (Qty. 3)
G = 2-56 x .250" F/F Standoff (Qty. 3)
H = 2-56 x .250" Pan Head Screw (Qty. 3)
I = FreeWave Radio Cable (with Nut and Washer)
J = FreeWave Radio Module

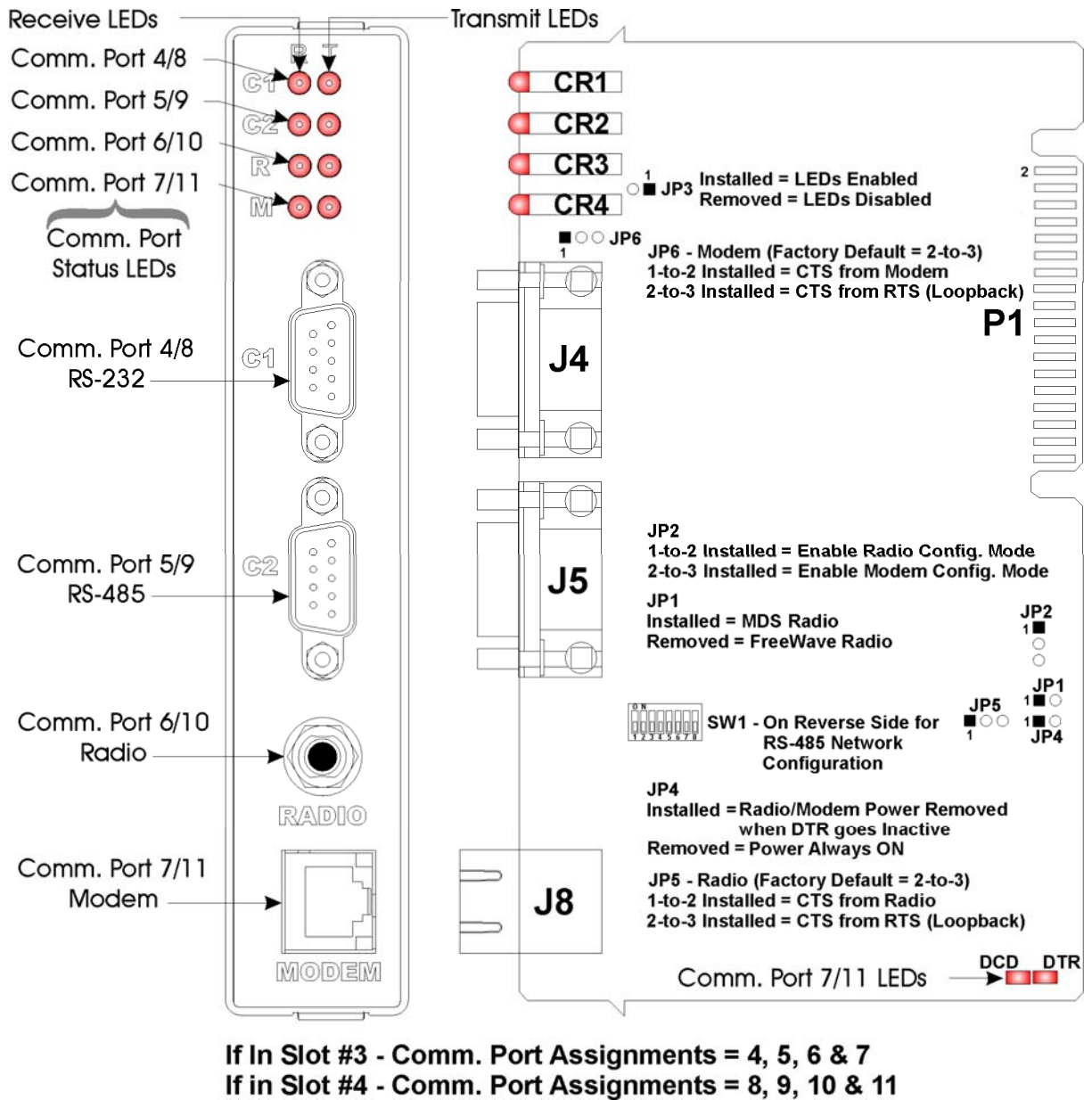**Figure C-4A - ECOM Module Component Identification Diagram #1**

Figure C-4B - ECOM Module Component Identification Diagram #2

Microwave Data System Inc. MDS TransNET OEM™ Spread Spectrum Data Transceiver: Operates in the 902 to 928 MHz range (20 miles).

Installation steps below support user installation and configuration of a Spread Spectrum Modem.

- Mount the radio (Spread Spectrum Modem) onto the Expansion Comm. Module. Remove the nut and washer from the internal coaxial RF cable supplied with the ECOM Module. Remove the plug from the front of the ECOM Cover and insert the in-ternal coaxial RF cable's SMA connector (straight end with flat area on top) through the rear of the ECOM Cover. Install the washer and nut to secure the internal coaxial RF cable to the front of the ECOM Cover. Install the other end of the internal coaxial RF cable to the radio's RF antenna connector. Install the Expansion Comm. Module into Slot 3 or 4 of a base **Control**Wave **EFM**. Install the user supplied coaxial RF cable between the ECOM Cover's SMA connector and the remote antenna.
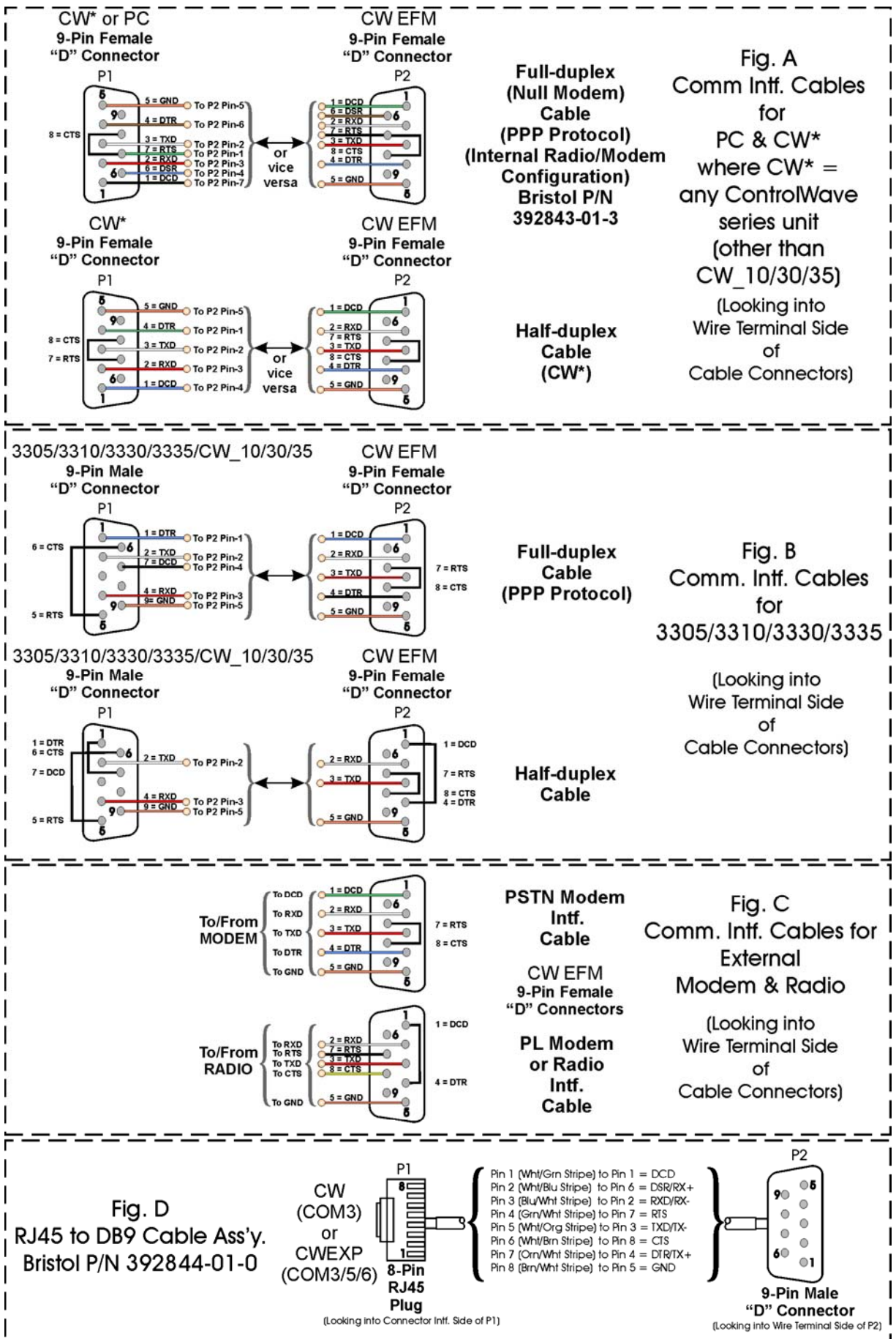
Figure C-5 - Communication Port RS-232 Cable Wiring Diagram

- For FreeWave Radio:

  Follow the Tuning Transceiver Performance" section of the FreeWave Technologies Inc. <u>FreeWave Spread Spectrum Wireless Data Transceiver User Manual</u> to configure the radio.

  For MDS Radio:

  Refer to section 3.3 "Initial Power-Up & Configuration" within the <u>MDS TransNet OEM Integration Guide</u> and if necessary for more information on connecting a PC terminal and preparing it for use, refer to section 9.0 "PROGRAMMING REFERENCE."

Note:

To invoke the setup program, connect the radio (via ECOM1 port COM4 or ECOM2 port COM8) to a terminal program (such as HyperTerminal) via a null modem cable (see Figure C-5A), put the radio into setup mode and set the parameters for the terminal to those of Table C-5 below. The setup program is invoked by connecting Pins 2 and 3 of ECOM Bd. Jumper Post JP2 via a Suitcase Jumper.

Table C-5 - Radio Setup Menu Terminal Settings

PARAMETERS	SETTINGS
Baud Rate	19,200
Data Rate	8
Parity	None
Stop Bits	1
Parity Check	None/Off
Carrier Detect	None/Off
Flow Control	Xon/Xoff

<u>56K PSTN Modem Port</u>

An optional 56K PSTN Hayes type Modem can be mounted piggy-back on each Expansion Communications Module and is assigned port status as follows: COM7 for ECOM1 and COM11 for ECOM2. The Model MT5634SMI Modem module is manufactured by MultiTech System and can be user configured for PSTN operation. DTE/DCE serial data can be clocked into (transmit) or out of (receive) the modem at a rate up to 115.2kHz.

Modems are supplied in kit form with all the hardware required for user installation onto an Expansion Communications Module. Figure C-4 shows the modem mounted on the Expansion Comm. Module. Modems are user installed onto the ECOM Module and their associated Ports are setup during installation in the Ports Page of the Flash Configuration Utility. The Flash Configuration Utility is accessed via NetView or LocalView.

A Terminal Emulation program such as HyperTerminal is used to profile the modem via AT commands. Users typically use AT commands only when checking the modem's active or stored profile or when reconfiguring a modem, e.g., to turn auto answer on or off, etc.

Step 1. Hardware Configuration (Continued)

5. Remove and configure each I/O Module for its intended application. After configuration, install them into the **Control**Wave **EFM** Base Assembly Chassis. I/O Modules may reside in a **Control**Wave **EFM** Chassis as follows:

Base Housings - Slots 3 & 4 (in lieu of Expansion Comm. Modules) & Slots 5 through 8
Expansion Housings - Any Slot

Install I/O wiring to each I/O Module (see Figures C-6 through C-10). Install a communications cable between the **Control**Wave **EFM** and a Model 3808 Transmitter (Network of Transmitters) if required (see Figures C-11 & C-12).
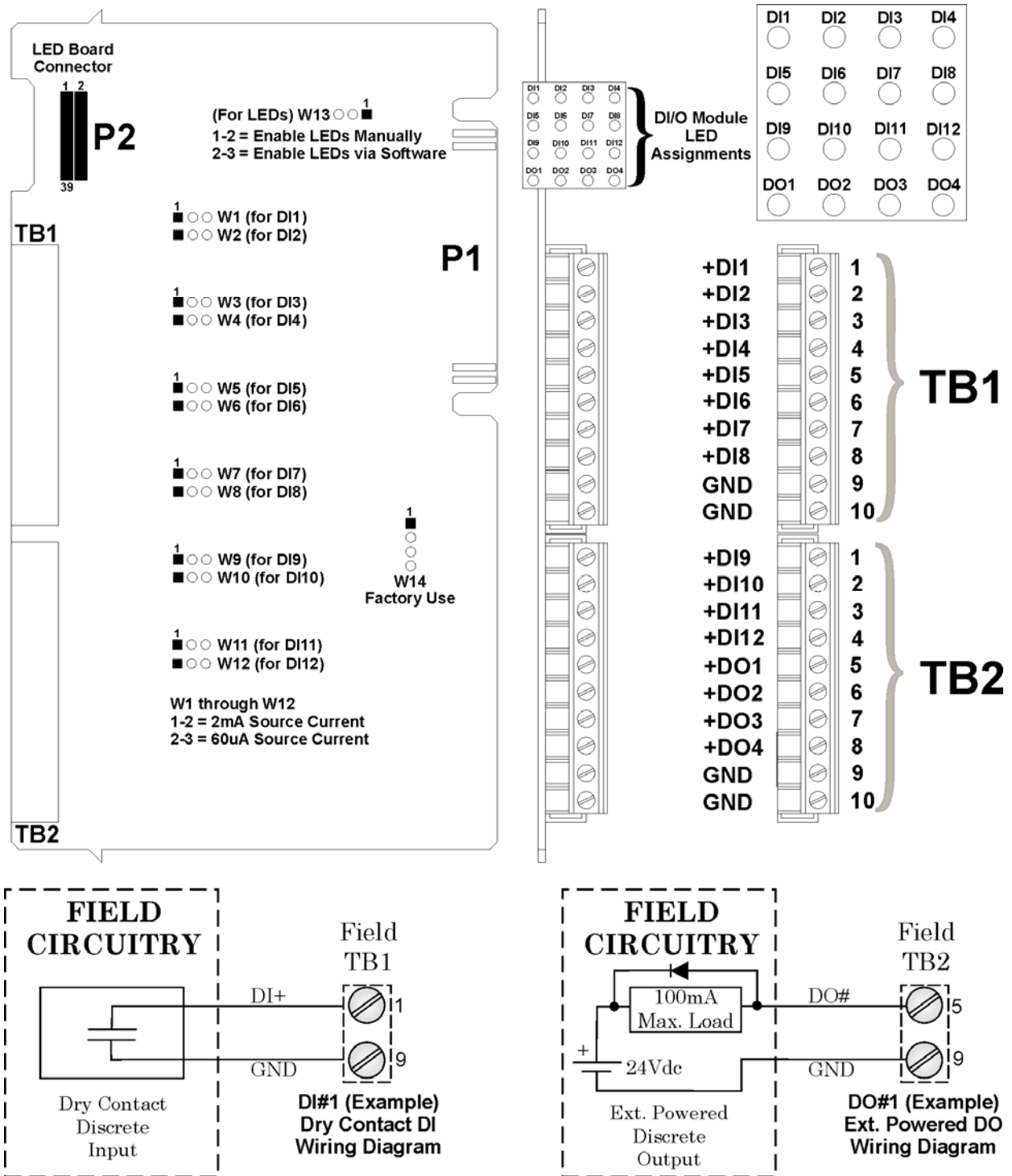

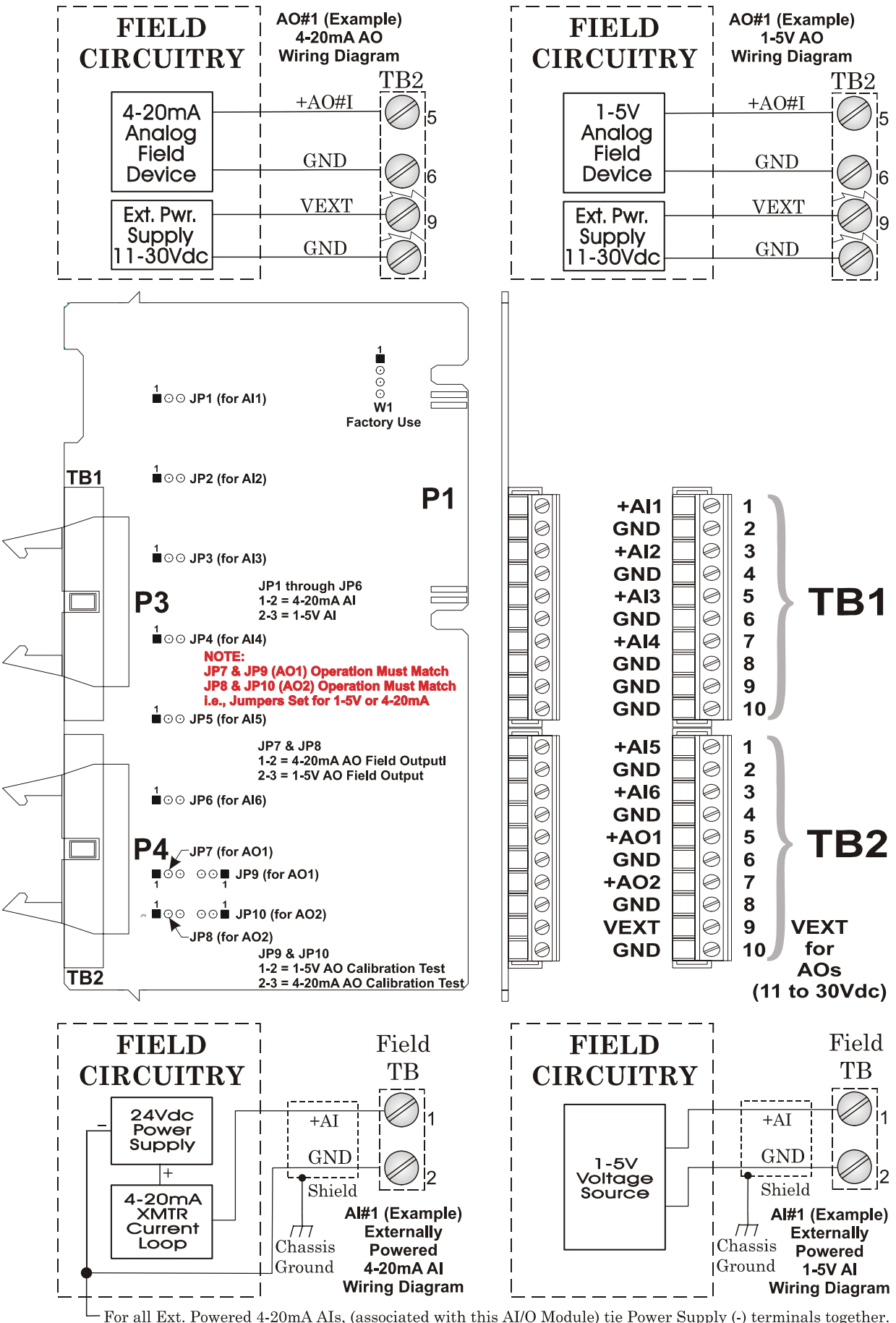**Figure C-6 - Non-Isolated DI/O Module Configuration Diagram**

FIELD CIRCUITRY

AO#1 (Example)
4-20mA AO
Wiring Diagram

4-20mA Analog Field Device		TB2
	+AO#I	5
	GND	6
Ext. Pwr. Supply 11-30Vdc	VEXT	9
	GND	

FIELD CIRCUITRY

AO#1 (Example)
1-5V AO
Wiring Diagram

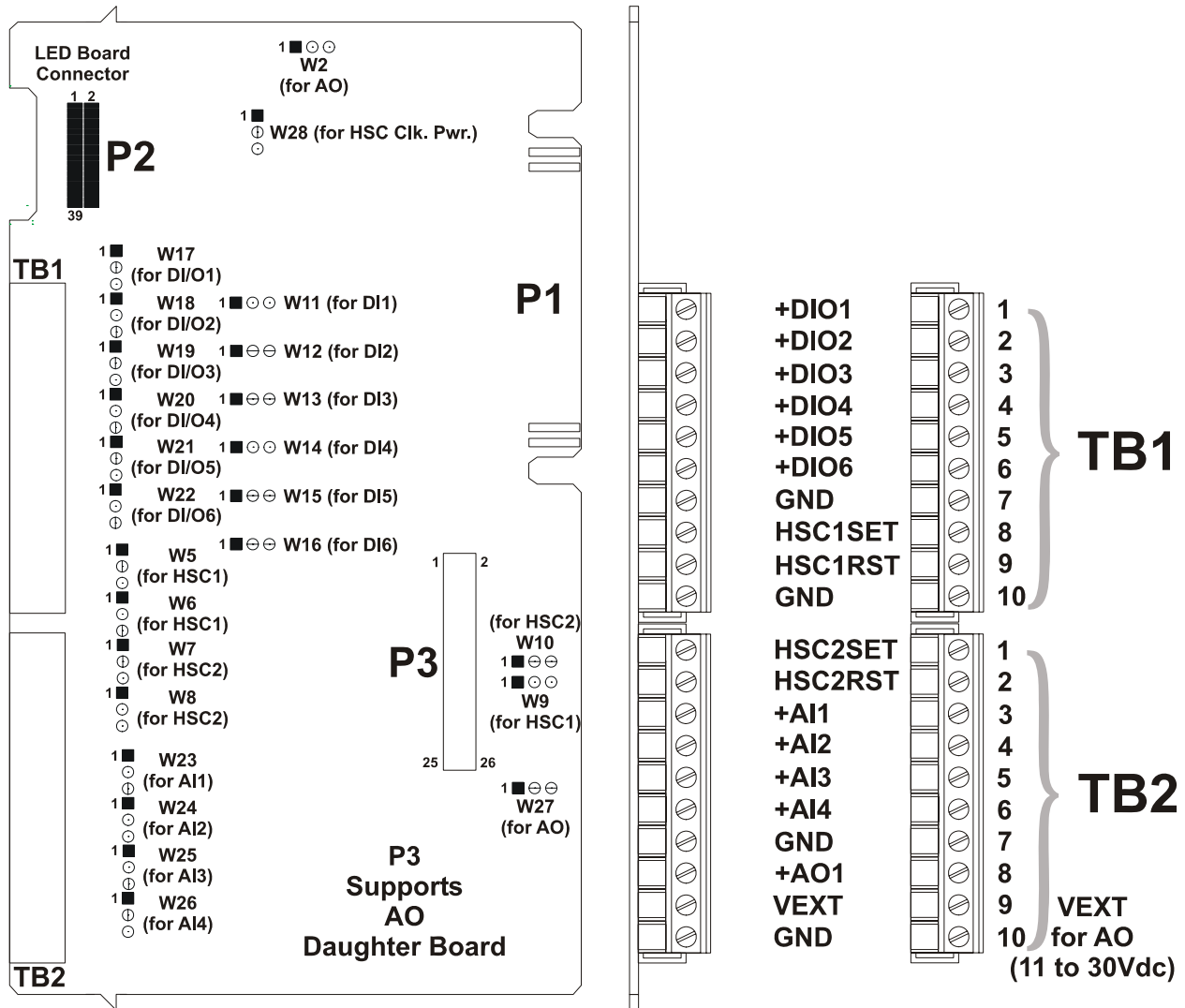| 1-5V Analog Field Device		TB2
	+AO#I	5
	GND	6
Ext. Pwr. Supply 11-30Vdc	VEXT	9
	GND	

1
W1
Factory Use

TB1

JP1 (for AI1)
JP2 (for AI2)
JP3 (for AI3)

P3

P1

JP1 through JP6
1-2 = 4-20mA AI
2-3 = 1-5V AI

JP4 (for AI4)

NOTE:
JP7 & JP9 (AO1) Operation Must Match
JP8 & JP10 (AO2) Operation Must Match
i.e., Jumpers Set for 1-5V or 4-20mA

JP5 (for AI5)

JP7 & JP8
1-2 = 4-20mA AO Field Outputl
2-3 = 1-5V AO Field Output

JP6 (for AI6)

P4
JP7 (for AO1)
JP9 (for AO1)
JP10 (for AO2)
JP8 (for AO2)

JP9 & JP10
1-2 = 1-5V AO Calibration Test
2-3 = 4-20mA AO Calibration Test

TB2

+AI1		1
GND		2
+AI2		3
GND		4
+AI3		5
GND		6
+AI4		7
GND		8
GND		9
GND		10

TB1

+AI5		1
GND		2
+AI6		3
GND		4
+AO1		5
GND		6
+AO2		7
GND		8
VEXT		9
GND		10

TB2

VEXT
for
AOs
(11 to 30Vdc)

FIELD CIRCUITRY

Field TB

24Vdc Power Supply		
4-20mA XMTR Current Loop	+AI	1
	GND	2

Shield

Chassis Ground

AI#1 (Example)
Externally
Powered
4-20mA AI
Wiring Diagram

FIELD CIRCUITRY

Field TB

1-5V Voltage Source	+AI	1
	GND	2

Shield

Chassis Ground

AI#1 (Example)
Externally
Powered
1-5V AI
Wiring Diagram

For all Ext. Powered 4-20mA AIs, (associated with this AI/O Module) tie Power Supply (-) terminals together.

Figure C-7 - Non-isolated AI/O Module Configuration Diagram

W6 LED Enable
1-2 = Enable LEDs Manually
2-3 = Enable LEDs via Software

P2 LED Board Connector

TB1

HSC2 Current Control
W10   W9

W2

W1

HSC1 Current Control
W7   W8

W14   W13
HSC4 Current Control

W4

W3

W11   W12
HSC3 Current Control

TB2

W1 through W4
Configures HSC1 through HSC4
(Respectively)
1-2 = Enable HSC Debounce
2-3 = Disable HSC Debounce

W7 Through W14
Current Control Jumpers
1-2 = Additional 2mA Load
2-3 = 200uA Source

P1

HSC1 HSC2 HSC3 HSC4

High Speed Counterl Module LED Assignments

HSC1SET		1
GND		2
HSC1RST		3
GND		4
GND		5
HSC2SET		6
GND		7
HSC2RST		8
GND		9
GND		10

TB1

HSC3SET		1
GND		2
HSC3RST		3
GND		4
GND		5
HSC4SET		6
GND		7
HSC4RST		8
GND		9
GND		10

TB2

FIELD CIRCUITRY — Field TB
HSCSET 1
GND DIGITAL 2
HSCRST 3
HSC#1 (Example)
Internally Sourced
Debounce Enabled
Wiring Diagram

FIELD CIRCUITRY — Field TB
HSCSET 1
GND DIGITAL 2
HSC#1 (Example)
Internally Sourced
Debounce Disabled
Wiring Diagram

Figure C-8 - Non Isolated HSC Module Configuration Diagram

Step 1. Hardware Configuration (Continued)

6. Install a ground wire between the Chassis Ground Lug and a known good Earth Ground (also see Supplement Guide S1400CW).

    ControlWave **EFM** Housings are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Chassis Ground Lug and a known good Earth Ground. The cases of the various **Control**Wave **EFM** Modules are

connected to Chassis Ground when they have been installed and secured via their two Captured Panel Fasteners. As an extra added precaution, it is recommended that a #14 AWG wire be run from SCM Power Connector TB1-3 (Chassis Ground) to the same known good Earth Ground. The following considerations are provided for the installation of **Control**Wave **EFM** system grounds.

Figure C-9 - Non-isolated Mixed I/O Module Configuration Diagram

Figure C-10 - Non-isolated Mixed I/O Module Wiring Diagram
(see Figure C-9 for Mixed I/O Module Configuration Diagram)

- Chassis Ground Lug to Earth Ground wire size should be #4 AWG. It is recommended that stranded copper wire is used and that the length should be as short as possible.

- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).

- The wire ends should be tinned with solder prior to insertion into the Chassis Ground Lug. *Note: Use a high wattage Soldering Iron.*

- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground

Step 1. Hardware Configuration (Continued)

7. Install the Bezel/Bezels so that the I/O Modules are covered.

8. Install RTD (wiring and Probe) (see Section 2.3.5 of this manual).

9. Install the Rechargeable Lead Acid Battery and Solar Panel (if provided) (see Sections 2.3.9.3 and 2.3.9.4.

10. Connect DC Power wiring to the **Control**Wave **EFM's** SCM Module (see Section 2.3.9, 2.3.9.1 and 2.3.9.2 and Figure C-2).

    SCM Connector TB1 provides 3 input connections for bulk power as follows:

    TB1-1 =   (+VIN) (+4.5/4.9V to +16.0V dc for +6V) (+9.6/10.3V to +16.0V dc for +12V)
    TB1-2 =   (-VIN) (Supply Ground)
    TB1-3 =   Chassis Ground - CHASSIS (⏚)

11. Apply power to the **Control**Wave **EFM**. Continue with Steps 2 through 6 below and Section 2.4.1, and the **Control**Wave **EFM** will be ready for on line operation.
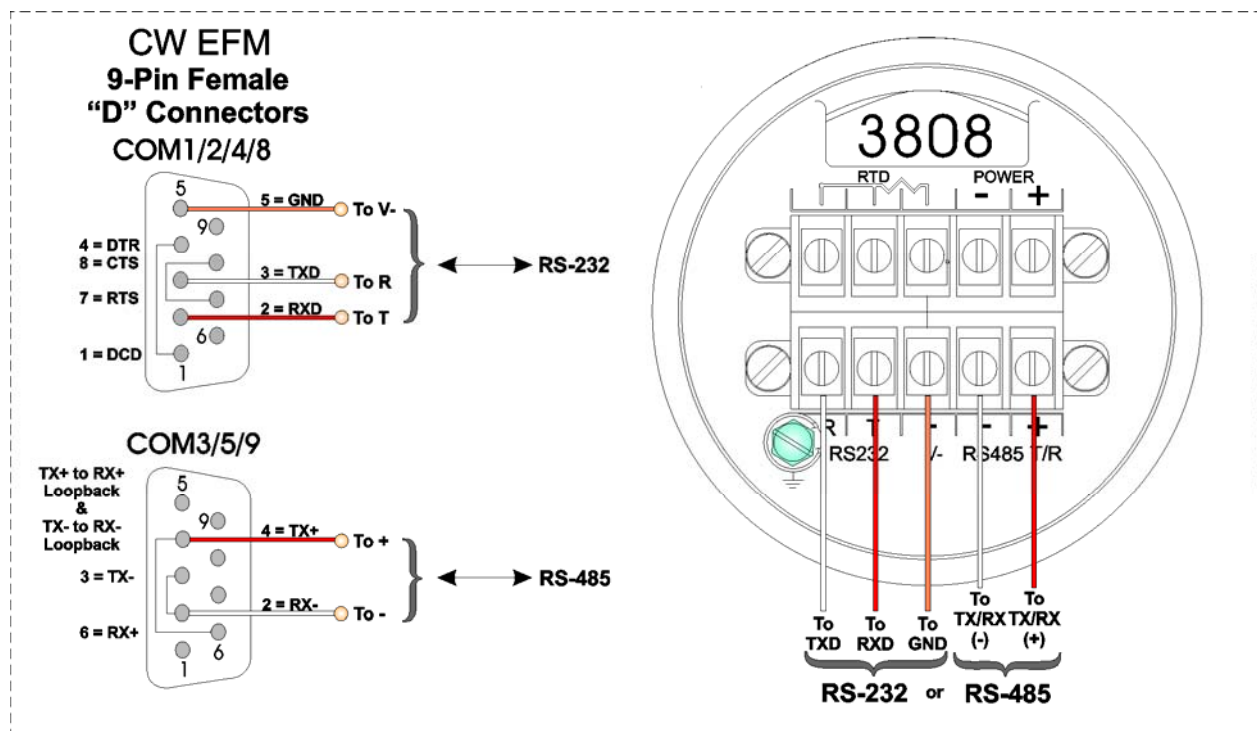
Figure C-11
Model 3808 Transmitter to Control Wave **EFM Comm. Cables**
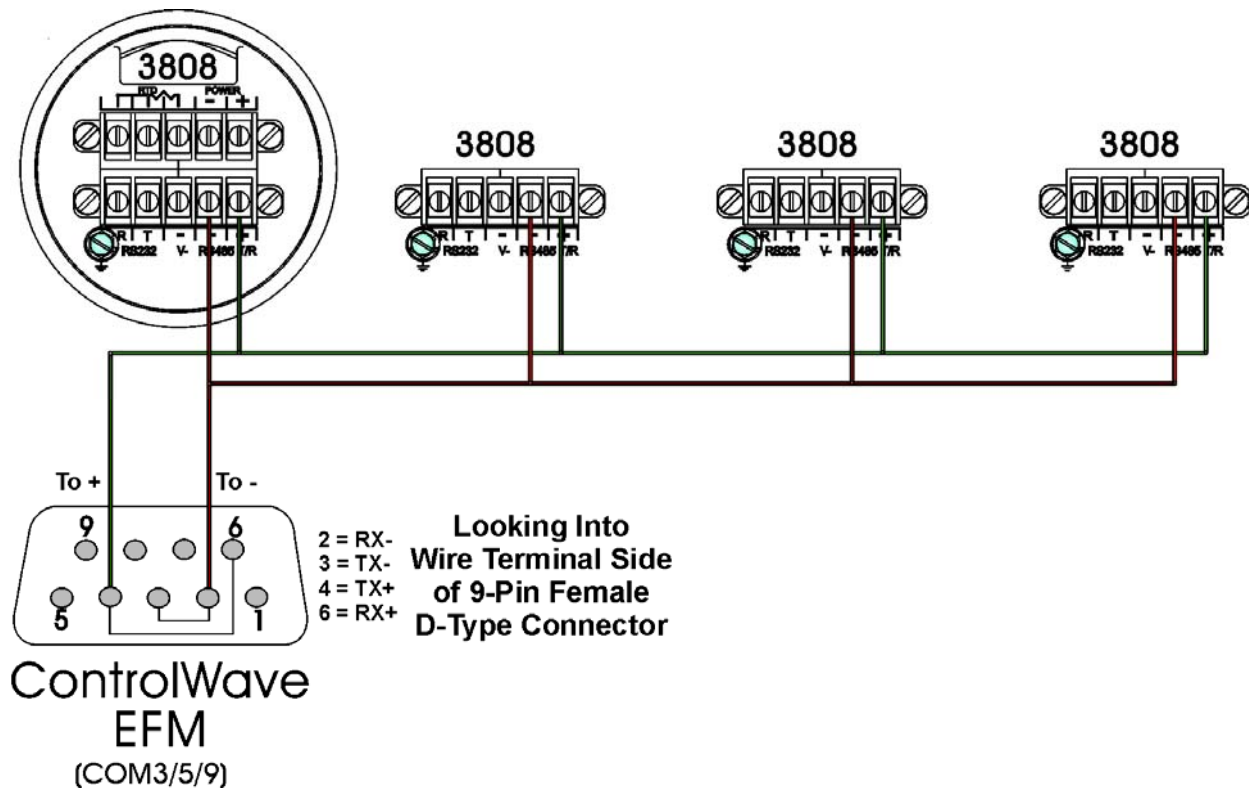
Figure C-12 - Control Wave**EFM to 3808s - RS-485 Network Diagram**

Step 2. Software Installation on the PC Workstation

ControlWave **Designer** software will have to be installed on the PC if the **Control**Wave **EFM** is to be utilized in an application other than that supported by the standard load. This is accomplished by installing the **Control**Wave **Designer Package** from the Open BSI CD ROM.

You must install the **Open BSI Network Edition**. For information on minimum system requirements and more details of the installation, see the installation procedure in Chapter 2 of the *Open BSI Utilities Manual* (document # D5081).

If you have an older version of ControlWave Designer already installed:

Beginning with **Control**Wave Designer Version 3.3, the copy protection key (dongle) is NOT required. Prior to installing **Control**Wave Designer 3.3 or newer, you MUST remove the hardware dongle from the parallel port of your PC workstation. Otherwise, when you subsequently start **Control**Wave Designer, it will operate only in 'DEMO' mode, and will limit the available system resources.

IMPORTANT:
When you start Control Wave **Designer, you will be reminded to register the software. Unregistered software can only be used for a maximum of 30 days. For more information on the registration process, see Chapter 2 of the Open BSI Utilities Manual (document# D5081).**

Step 3. Establish Communications using either LocalView or NetView, and Run the Flash Configuration Utility

Communications must be established with the **Control**Wave **EFM** using either LocalView or NetView.

The **Control**Wave **EFM** ships from the factory with a default Flash configuration. Most users will need to edit this configuration to set the BSAP local address (IP address if using PPP), user accounts, and port parameters. This can be done in one of two ways:

- Either open the supplied Flash Configuration Profile (FCP) file and modify it, directly in the Flash Configuration Utility, or in a text editor,

- Or retrieve existing Flash Parameters directly from the unit, and edit them in the Flash Configuration Utility.

Detailed information on the Flash Configuration Utility and LocalView is included in Chapter 5 of the *Open BSI Utilities Manual* (document # D5081). NetView is described in Chapter 6 of that same manual.

Step 4. Modification of the Application-Specific Control Strategy (OPTIONAL)

ControlWave **EFM** electronic flow meters are shipped with the EFM program already loaded. However, you can create your own application-specific control strategy using **Control**Wave Designer. This involves opening a new project using the 'CWMicro' template, defining I/O points using the I/O Configurator, and creating a program using one or more of the five supported IEC 61131 languages (FBD, ST, SFC, LD, or IL). Some of these languages are text based, others are graphical diagrams. The choice is up to you, depending upon your particular application.

The ***Control*Wave *MICRO** Quick Setup Guide* (document # D5124) includes a simple LD example. Additional examples are included in the manual, *Getting Started with **Control*Wave Designer** (document # D5085). More detailed information about **Control**Wave Designer and IEC 61131 is included in the ***Control*Wave Designer Reference Manual** (document # D5088).

The ACCOL3 Firmware Library, which is automatically accessible through the template referenced above, includes a series of function blocks which perform a variety of process control and communication functions. These can be included within your program to perform various duties including PID control, alarming, calculations, etc. Detailed information about each function block is included in the **Control**Wave Designer on-line help files.

On the variables declaration page(s) in **Control**Wave Designer, you will need to mark any variable you want to make accessible to external programs, such as Open BSI's DataView utility, as **"PDD"**. Similarly, any variables which should be collected into a database, or exported using the OLE for Process Control (OPC) Server must be marked as **"OPC."** Variables marked as OPC can be built into a text file by the **OpenBSI Signal Extractor.** The text file can then be used in the creation of a database for human machine interface (HMI) software such as OpenEnterprise or Iconics' Genesis. These HMI software packages require that the **"Datatype conversion enable"** option be selected when generating the file using Signal Extractor. Information about the OpenBSI Signal Extractor is included in Chapter 12 of the *Open BSI Utilities Manual* (document # D5081).

Once the program has been created, it is assigned to an executable task. The entire project is then saved and compiled.

NOTE: From this point on, the order of steps may be varied, somewhat, depending upon the requirements of the user's application. If you modify the standard EFM program, you may need to modify the standard web pages associated with it. (See Step 5, below).

Step 5. Use Standard Web Pages Provided to Select Options in the Standard Control Strategy

The **Control**Wave **EFM** has a standard set of web pages for configuration purposes (stored on a PC) that let you enter parameters, and configuration options for the standard EFC program (see Step 4, above). If you modify the standard EFM program, you may need to modify the standard web pages. If you create your own application program (instead of using the standard one), you may create your own web pages using Bristol ActiveX controls discussed in the *Web_BSI Manual* (document # D5087).

You can use whichever HTML creation package you want to create the pages, however, all **Control**Wave **EFM** related web pages (whether standard or user-created) must be viewed within Microsoft® Internet Explorer. Web pages are stored on a PC workstation.

Step 6. Create an Open BSI Network Containing the ControlWave EFM, or ADD the Control Wave **EFM to an Existing Open BSI Network**

In order for the **Control**Wave **EFM** unit to function as part of a Bristol network, it is necessary to include it in the Bristol network.

If no Bristol network exists:
You need to run Open BSI's NetView software on the PC workstation in order to define a Bristol network. A series of software wizards are used to define a Network Host PC, a network, and the RTUs (controllers) assigned to the network. Finally, communication lines must be specified which handle the address assigned to the **Control**Wave **EFM**. Chapters 3 and 4 of the *Open BSI Utilities Manual* (document # D5081) include 'quick start' examples for performing these steps. More detailed information is included in the NetView chapter (Chapter 6) of D5081.

If a Bristol network already exists:
You will need to add the **Control**Wave **EFM** to the existing network using Net-View's RTU Wizard. Chapter 6 of the *Open BSI Utilities Manual* (document # D5081) includes different sub-sections depending upon whether you are adding the unit to a BSAP network, or an IP network.

Step 7. If applicable, download new or modified control strategy (OPTIONAL)

If you modified the standard EFM program, or substituted your own program, compile and download the new or modified program into the unit, using either ControlWave Designer, or the Open BSI 1131 Downloader. In this case, you download the control strategy into the BOOT project area of FLASH memory; this ensures that if the **Control**Wave **EFM** is reset, or if there has been a failure of the backup battery, the control strategy can be restarted from the beginning, i.e. from the BOOT project in FLASH memory. To download the project, see Downloading the Application Load.

Downloading the Application Load

Any **Control**Wave **EFM** must have a configured application load before it can be placed into operation. For units not shipped with the 'Standard Load,' this will require connection of the **Control**Wave **EFM** to a PC running Windows NT (4.0 or higher), Windows 2000 or Windows XP Professional and equipped with **Control**Wave Designer software & OpenBSI software. Configuration of the application load must be performed by an individual familiar with the various programming tools. The following software user documentation is referenced:

Getting Started with **Control**Wave Designer Manual - D5085
ControlWave Designer Reference Manual - D5088
Open BSI Utilities Manual - D5081
Web_BSI Manual - D5087

An application load download can be initiated, i.e., from **Control**Wave Designer, or from the OpenBSI 1131 Downloader for **Control**Wave **EFM** Nodes.

1. Make sure that the System Controller Module's Mode Switch (SW1) is set in 'Local Mode,' i.e., SW1-1 set to the **OPEN** (**Right**) position and SW1-2 set to the **CLOSED** (**Left**) position.

   Note: From the factory, COM1 defaults to 115.2 kbd (RS-232) using the Internet Point to Point Protocol (PPP). Don't connect COM1 to a PC unless the PC's RS-232 port in question has been configured for PPP.

2. Once the **Control**Wave **EFM** project has been defined, communications and configuration parameters have been set, perform the download according to either '**Control**Wave Designer' (see D5088 - chapter 11) or 'The Open BSI 1131 Downloader' (see D5081 - Chapter 7).

3. After the download has been completed leave the System Controller Module's Mode Switch (SW1) in the 'Local Mode' position.

LED Checks

All **Control**Wave **EFM** Modules contain light emitting diodes (LEDs) that provide operational and diagnostic functions. **Control**Wave **EFM** LED designations and functions are provided in Table C-6. A brief synopsis of the individual module LEDs is provided as follows:

SCM: 1 IDLE LED, 1 Watchdog LED, & 6 System Status LEDs
CPUM: 2 LEDs per Comm. Port = 6
ECOM1: 2 LEDs per Comm. Port = 8
ECOM2: 2 LEDs per Comm. Port = 8
AI/OM: None
DI/O: 1 LED per DI x 12 = 12 DI LEDs, 1 LED per DO x 4 = 4 DO LEDs
HSC: 1 LED per HSC x 4 = 4 HSC LEDs
MI/OM: None

Table C-6 - LED Assignments

Module	LED Name	LED Color	Function
SCM *	IDLE	Red	ON = Idle
SCM *	WD	Red	ON = Watchdog Condition - OFF = Normal
SCM	6 STATUS	Red	See Figure C-13
CPUM	C1 RX (Comm 1)	Red	ON = RX Activity (Top-Left - see Fig C-3)
CPUM	C1 TX (Comm 1)	Red	ON = TX Activity (Top-Right -see Fig C-3)
CPUM	C2 RX (Comm 2)	Red	ON = RX Activity (Middle-Left - see Fig C-3)
CPUM	C2 TX (Comm 2)	Red	ON = TX Activity (Middle-Right -see Fig C-3)
CPUM	C3 RX (Comm 3)	Red	ON = RX Activity (Bottom-Left - see Fig C-3)
CPUM	C3 TX (Comm 3)	Red	ON = TX Activity (Bottom-Right -see Fig C-3)
ECOM1	C1 RX (Comm 4)	Red	ON = RX Activity (Top-Left - see Fig C-4)
ECOM1	C1 TX (Comm 4)	Red	ON = TX Activity (Top-Right -see Fig C-4)
ECOM1	C2 RX (Comm 5)	Red	ON = RX Activity (2nd from Top-Left - see Fig C-4)
ECOM1	C2 TX (Comm 5)	Red	ON = TX Activity (2nd from Top-Right -see Fig C-4)
ECOM1	Radio RX (Comm 6)	Red	ON = RX Activity (3rd from Top-Left - see Fig C-4)
ECOM1	Radio TX (Comm 6)	Red	ON = TX Activity (3rd from Top-Right -see Fig C-4)
ECOM1	Modem RX (Comm 7)	Red	ON = RX Activity (Bottom-Left - see Fig C-4)
ECOM1	Modem TX (Comm 7)	Red	ON = TX Activity (Bottom-Right -see Fig C-4)
ECOM2	C1 RX (Comm 8)	Red	ON = RX Activity (Top-Left - see Fig C-4)
ECOM2	C1 TX (Comm 8)	Red	ON = TX Activity (Top-Right -see Fig C-4)
ECOM2	C2 RX (Comm 9)	Red	ON = RX Activity (2nd from Top-Left - see Fig C-4)
ECOM2	C2 TX (Comm 9)	Red	ON = TX Activity (2nd from Top-Right -see Fig C-4)
ECOM2	Radio RX (Comm 10)	Red	ON = RX Activity (3rd from Top-Left - see Fig C-4)
ECOM2	Radio TX (Comm 10)	Red	ON = TX Activity (3rd from Top-Right -see Fig C-4)
ECOM2	Modem RX (Comm 11)	Red	ON = RX Activity (Bottom-Left - see Fig C-4)
ECOM2	Modem TX (Comm 11)	Red	ON = TX Activity (Bottom-Right -see Fig C-4)
DI/OM	Input (12 LEDs) (1 Per Point)	Red	LED ON = Input is present LED OFF = Input is not present (see Fig C-6)
DI/OM	Output (4 LEDs) (1 Per Point)	Red	LED ON = Output is ON (see Fig C-6)
HSCM	INPUT (4 LEDs) (1 Per Point)	Red	LED ON = Input activity on input is present LED OFF = No activity on input (see Fig C-8)

* = see Figure C-2

Status LED HEX Codes

00 = **Application Running**
01 = **Unit in Diagnostic Mode**
03 = **Unit Running Diagnostics**
04 = **Flash XSUM Error**
05 = **Error Initializing Application Device**
07 = **Flash Programming Error**
08 = **Using Factory Defaults (Flashed at start)**
09 = **Battery Failure Detected (Flashed at startup)**
0A = **Currently Loading Boot Project**
0B = **System Initialization in Progress**
10 = **Waiting in Recovery Mode**
11 = **Error Testing SDRAM**
12 = **Error Testing SRAM**
20 = **Application Loaded**
28 = **Stopped at Breakpoint**
30 = **No Application Loaded**
38 = **Running with Break Points**
3B = **Waiting for Power-down (after NMI)**
3E = **Waiting for Updump to be Performed**
3F = **Unit Crashed (Watchdog Disabled)**

Figure C-13 - SCM Status LED Hexi-decimal Codes

Appendix D
ECOM MODULE RADIO/MODEM INSTALLATION GUIDE

D1.1 RADIO INSTALLATION & CONFIGURATION

D1.1.1 Installing an Internal FreeWave Radio (FGR09CSU)

FreeWave Radio Model GR09SCU is provided (for user installation) in a kit consisting of the following components:

- 2-56 x .188" Pan Head Screw (Qty. 3) - Fig. D2 Reference = 1
- 2-56 x .250" F/F Standoff (Qty. 3) - Fig. D2 Reference = 2
- 2-56 x .250" Pan Head Screw (Qty. 3) - Fig. D2 Reference = 3
- FreeWave Radio Cable (with Nut and Washer) - Fig. D2 Reference = 4
- FreeWave Radio Module - Fig. D2 Reference = 5

To install a Model FGR09SCU Radio onto an Expansion Communication Module, perform the following nine (9) steps:

1. Remove the Expansion Comm. Module from the unit in question (see Figure D1).

2. Grasp the Expansion Comm. Module with one hand. Squeeze both sides of the Cover Panel (just below the unit's top) and pull up and away to release the Cover Panel and EMI Gasket from the PCB (see Figure D2). **Note: If necessary, a small screwdriver can be used to pry the Cover Panel from the PCB.**

3. Install the three (3), F/F Standoffs (item2) to the rear of the FreeWave Radio via three (3), 2-56 x .250" Pan Head Screws (item 3) (through the PCB).

4. Mount the FreeWave Radio to the Exp. Comm. Module making sure that the interface connectors (J12 on Exp. Comm. Module) align. Secure the FreeWave Radio to the Exp. Comm. Module via three (3), 2-56 x .188" Pan Head Screws (item 1).

5. Plug the radio end of the Antenna Cable (item 4) into the FreeWave Radio's RF Connector.

6. If installing an optional MultiTech Model MT5634SMI Modem, proceed to Section D2.1 prior to installing the Antenna Cable to the Cover Panel; if not, install the antenna end of the Antenna Cable (item 4) through the EMI Gasket and Cover Panel. Secure the Antenna Cable to the Cover Panel via the Antenna Cable's washer and nut.

7. Remove Expansion Comm. Module Jumper JP1 and place it in storage, i.e., plugged onto pin 1 or 2.

8. Snap the Cover Panel onto the Expansion Comm. Module PCB and insert the ECOM Module into the appropriate Backplane Slot, i.e., Slot 3 or 4.
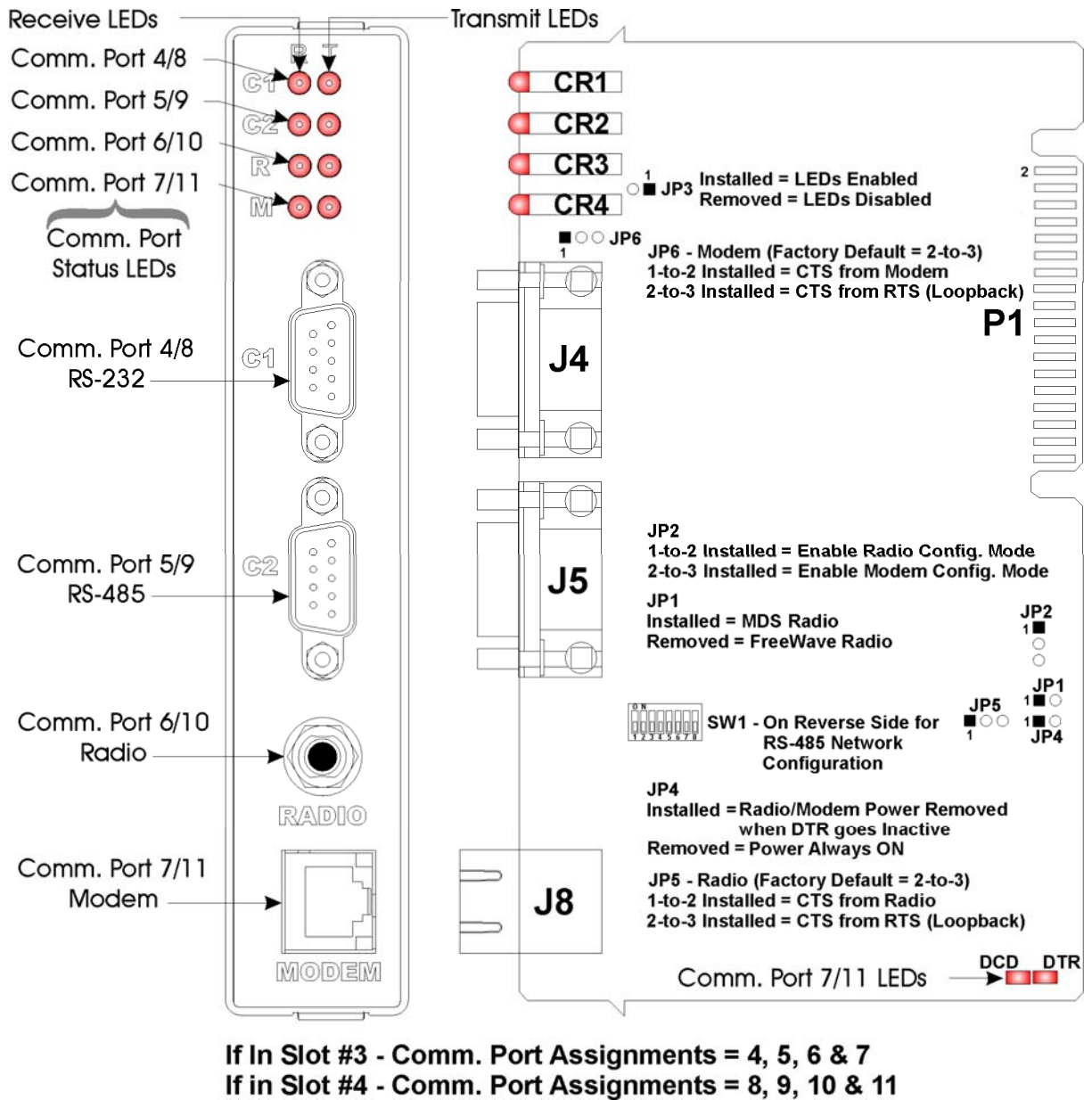
9. Apply power and test the unit.

Figure D1 – Expansion Comm. Module Component Identification Diagram

D1.1.2 Configuring the FreeWave Radio (FGR09CSU)

To configure a Model FGR09SCU Radio (installed on an Expansion Communication Module), perform the following eight (8) steps:

1. If required, remove the Exp. Comm. Module from the unit in question (see Figure. D1).

2. Place the radio into configuration ode by setting Expansion Comm. Module Jumper JP2 onto pins 1 and 2. This will enable configuration of the radio through Comm. Port 4 for radio on Comm. Port 6 (ECOM1) or through COMM. Port 8 for radio on Comm. Port 10 (ECOM2).

3. Connect a Full Duplex **Control**Wave Null Modem Cable (see Figure D3) between a PC and Comm. Port 4 (ECOM1) to configure radio on COMM. Port 6 (ECOM1) or Comm. Port 8 (ECOM2) to configure radio on COMM. Port 10 (ECOM2).

OPTION
Populated
by
Order

If In Slot #3
Comm. Port
Assignments
If In Slot #4

4/8

6/10

Cover Panel **EMI Gasket**

FreeWave Radio Kit Parts
1 = 2-56 x .188" Pan Head Screw (Qty. 3)
2 = 2-56 x .250" F/F Standoff (Qty. 3)
3 = 2-56 x .250" Pan Head Screw (Qty. 3)
4 = FreeWave Radio Cable (with Nut and Washer)
5 = FreeWave Radio Module

FreeWave
Radio
module

TEXT ORIENTATION

Exp Comm. Module's
FreeWave Radio
Connector J12
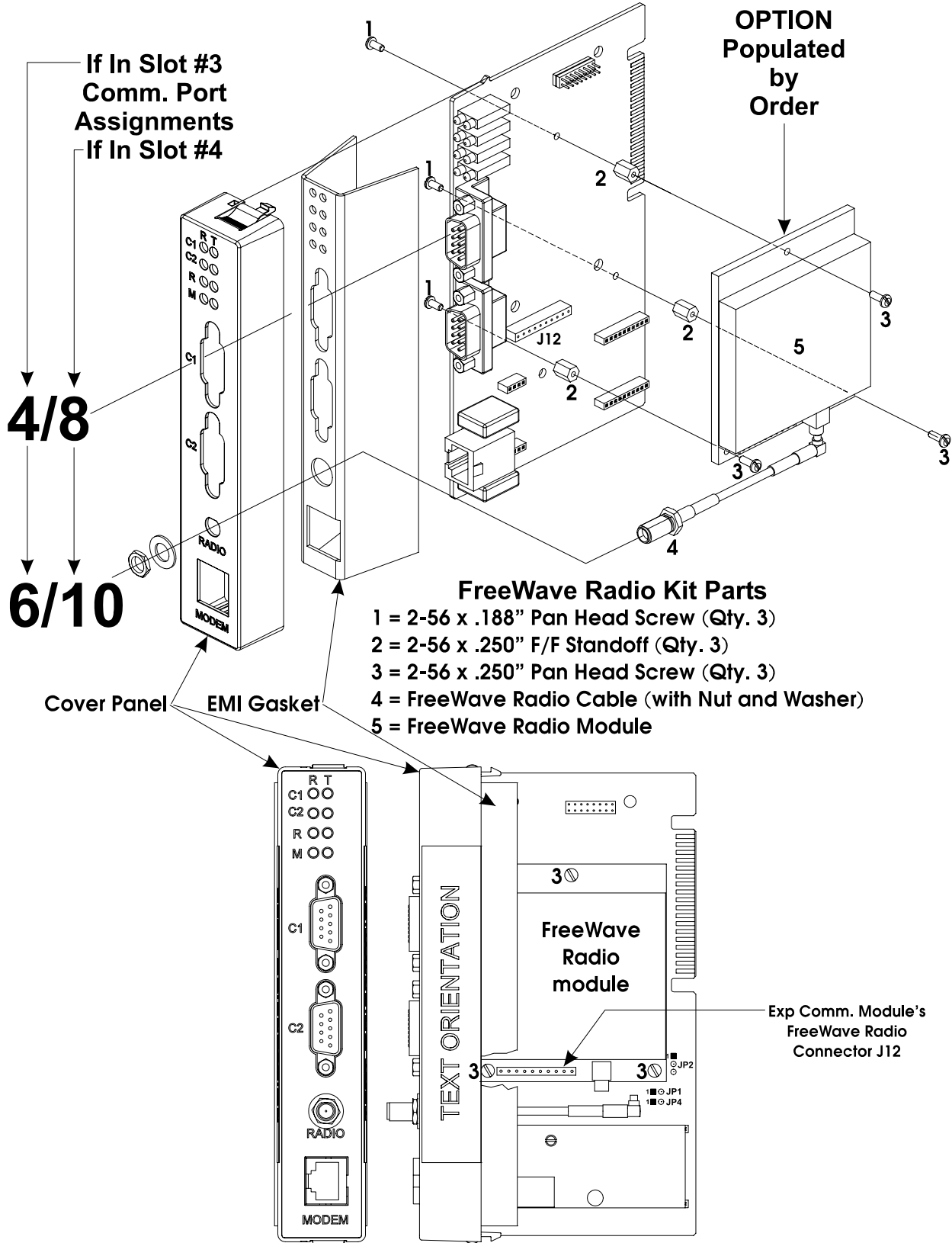
Figure D2 - FreeWave Radio Installation Diagram

4. Open Hyperterminal on the PC and set the PC communication port settings as follows:

   Bits per second: 19200
   Data bits: 8
   Parity: None
   Stop bit: 1
   Parity Check: None/Off
   Carrier Detect: None/Off
   Flow Control: Xon/Xoff

5. Cycle power to the **Control**Wave **MICRO/Control**Wave **EFM**. The FreeWave configuration menu will appear in Hyperterminal.

6. In the configuration menu, set the radio as a multipoint slave. Go to the edit book and type in the serial number of the Master Radio to which you want to communicate. Make sure the Baud Rate matches that of the Master Radio. Once settings have been implemented, press the Esc Key to exit the configuration menu.

7. Set Expansion Comm. Module Configuration Jumper JP2 into a storage position, i.e., parked (no connection).

8. Using Hyperterminal at the Master Radio, inter configuration mode and set the radio as a multipoint master. Using the edit book (in configuration mode) make sure that no serial number is set. Verify that the baud rate matches that of the Slave Radio.
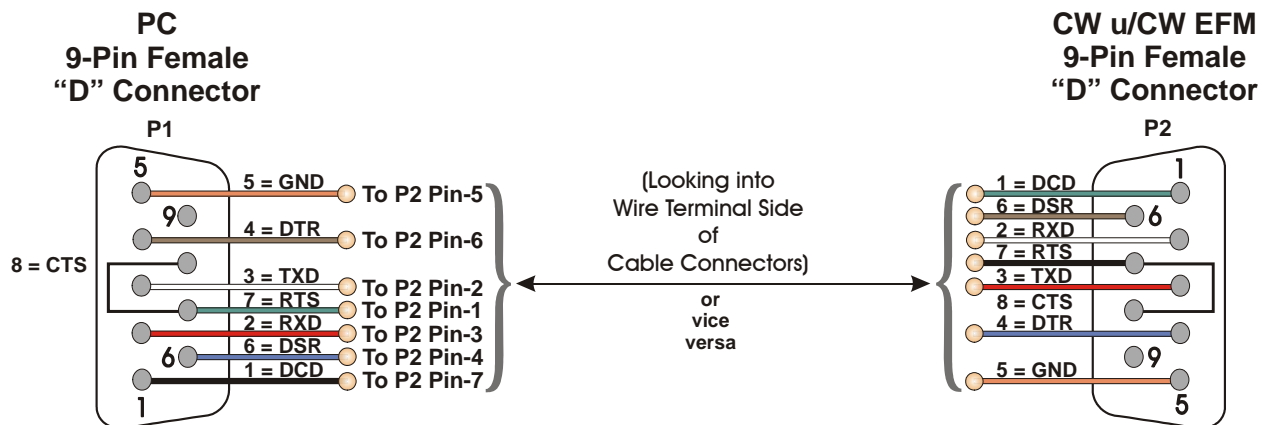
Figure D3 - (Internal Radio/Modem Configuration) BBI P/N 392843-01-3
Full-duplex Null Modem Cable Diagram

D1.1.3 Installing an Internal MDS Transnet OEM Radio

MDS Transnet OEM Radio is provided (for user installation) in a kit consisting of the following components:

- 6-32 x .188" Pan Head Screw (Qty. 4) - Fig. D4 Reference = 1
- 6-32 x .313" F/F Standoff (Qty. 4) - Fig. D4 Reference = 2
- 6-32 x .250" Pan Head Screw (Qty. 4) - Fig. D4 Reference = 3
- MDS Transnet Radio Cable (with Nut and Washer- Fig. D4 Reference = 4
- Swaged Standoff (Qty 4) - Built into CPU/System Controller Bd. - Fig. D3 Reference = E
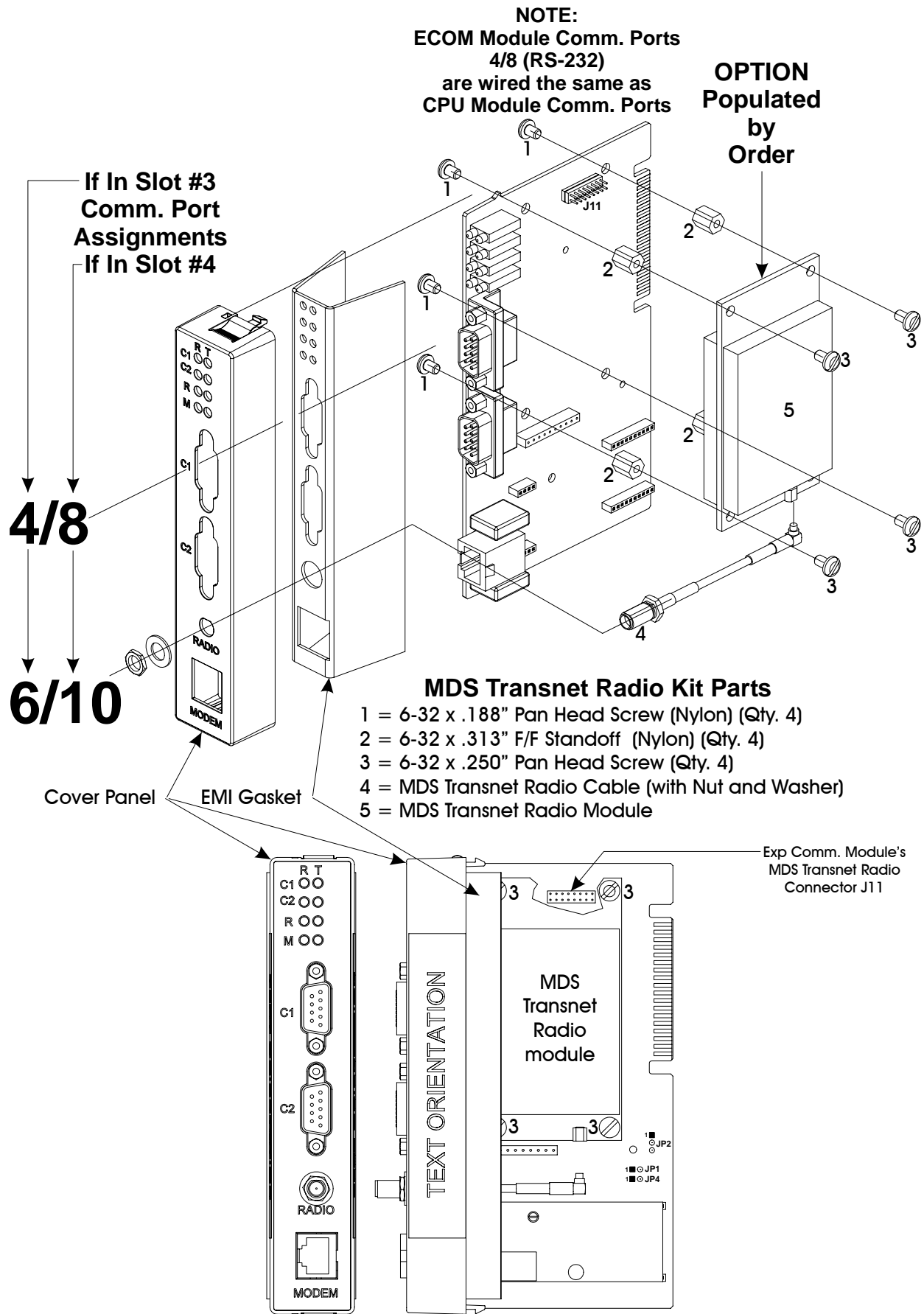- MDS Transnet Radio Module - Fig. D5 Reference = 5

**OPTION
Populated
by
Order**

**If In Slot #3
Comm. Port
Assignments
If In Slot #4**

4/8

6/10

J11

1

2

2

2

2

3

3

3

3

5

4

Cover Panel

EMI Gasket

MDS Transnet Radio Kit Parts

1 = 6-32 x .188" Pan Head Screw (Nylon) (Qty. 4)
2 = 6-32 x .313" F/F Standoff (Nylon) (Qty. 4)
3 = 6-32 x .250" Pan Head Screw (Qty. 4)
4 = MDS Transnet Radio Cable (with Nut and Washer)
5 = MDS Transnet Radio Module

R T
C1
C2
R
M

C1

C2

RADIO

MODEM

R T
C1 OO
C2 OO
R OO
M OO

C1

C2

RADIO

MODEM

TEXT ORIENTATION

MDS
Transnet
Radio
module

3

3

3

3

1 JP2

1 JP1
1 JP4

Exp Comm. Module's
MDS Transnet Radio
Connector J11

Figure D4 - MDS Transnet OEM Radio Installation Diagram

To install a MDS Transnet OEM Radio onto an Expansion Comm. Module, perform the following nine (9) steps (referring to Figure D-4):

1. Remove the Expansion Comm. Module from the unit in question (see Figure D1).

2. Grasp the Expansion Comm. Module with one hand. Squeeze both sides of the Cover Panel (just below the unit's top) and pull up and away to release the Cover Panel and EMI Gasket from the PCB (see Figure D2). **Note: If necessary, a small screwdriver can be used to pry the Cover Panel from the PCB.**

3. Install the four (4), F/F Standoffs (item2) to the rear of the MDS Transnet Radio via four (4), 6-32 x .250" Pan Head Screws (item 3) (through the PCB).

4. Mount the MDS Transnet Radio to the Exp. Comm. Module making sure that the interface connectors (J11 on Exp. Comm. Module) align. Secure the MDS Transnet Radio to the Exp. Comm. Module via four (4), 6-32 x .188" Pan Head Screws (item 1).

5. Plug the radio end of the Antenna Cable (item 4) into the MDS Transnet Radio's RF Connector.

6. If installing an optional MultiTech Model MT5634SMI Modem, proceed to Section D2.1 prior to installing the Antenna Cable to the Cover Panel; if not, install the antenna end of the Antenna Cable (item 4) through the EMI Gasket and Cover Panel. Secure the Antenna Cable to the Cover Panel via the Antenna Cable's washer and nut.

7. Make sure that Expansion Comm. Module Jumper JP1 is installed, i.e., plugged into the jumper pins.

8. Snap the Cover Panel onto the Expansion Comm. Module PCB and insert the ECOM Module into the appropriate Backplane Slot, i.e., Slot 3 or 4.

9. Apply power and test the unit.

D1.1.4 MDS Transnet OEM Radio Configuration Guidelines

To configure a MDS Transnet OEM Radio (installed on an Expansion Comm. Module), perform the following seven (7) steps:

1. Place the radio into configuration mode by placing Expansion Comm. Module Jumper JP2 onto pins 1 and 2. This will enable configuration of the radio through Comm. Port 4 for radio on Comm. Port 6 (ECOM1) or through COMM. Port 8 for radio on Comm. Port 10 (ECOM2).

2. Connect a Full Duplex **Control**Wave Null Modem Cable (see Figure D3) between a PC and Comm. Port 4 (ECOM1) to configure radio on COMM. Port 6 (ECOM1) or Comm. Port 8 (ECOM2) to configure radio on COMM. Port 10 (ECOM2).

3. Open HyperTerminal on the PC and set the PC communication port settings as follows:

Bits per second: 19200
Data bits: 8
Parity: None
Stop bit: 1

Parity Check: None/Off
Carrier Detect: None/Off
Flow Control: Xon/Xoff

4. Cycle power to the **Control**Wave **MICRO/Control**Wave **EFM**. After hitting the escape (Esc) key and then the carriage return twice (at approximately half second intervals), the right arrow (>) will appear.

5. In the configuration menu, set the radio mode using either the MODE M (master) or MODE R (remote) command. ***Note: There can be only one Master radio per network.*** Go to the edit book and type in the serial number of the network's Master Radio. Set a unique Network Address (1 - 65000) using the ADDR command. ***Note: All radios on the network must have the same Network Address.*** Make sure the Baud Rate of any Remote Radio matches that of the Master Radio. Set the radio's data interface parameters (bps: 1200 – 114200 bps), Data Bits: (8). Parity (N), Stop bits: (1). Once settings have been implemented, press the Esc Key to exit the configuration menu.

6. Set Expansion Comm. Module Configuration Jumper JP2 into a storage position, i.e., parked (no connection).

7. Apply power and test the unit.

D2.1 MODEM INSTALLATION & CONFIGURATION

D2.1.1 Installing an Internal MultiTech Modem (MT5634SMI)

MultiTech Modem Model MT5634SMI is provided (for user installation) in a kit consisting of the following components:

*   Nylon Support Post
*   MultiTech Modem Module

To install a Model MT5634SMI Modem onto an Expansion Communication Module, perform the following seven (7) steps:

1. Remove the Expansion Comm. Module from the unit in question (see Figure D1).

2. Unplug the Antenna Cable from the RF Connector on any installed Radio Module. Grasp the Expansion Comm. Module with one hand. Squeeze both sides of the Cover Panel (just below the unit's top) and pull up and away to release the Cover Panel and EMI Gasket from the PCB (see Figure D4). **Note: If necessary, a small screwdriver can be used to pry the Cover Panel from the PCB.**

3. Install the Nylon Support Post onto the Expansion Comm. Module.

4. Mount the MultiTech Modem to the Exp. Comm. Module making sure that the interface connectors (J6, J7, J9 & J10 on Exp. Comm. Module) align.

5. Plug the Antenna Cable(s) (if present - removed in Step 2) into the appropriate RF Connector of an installed Radio Module(s).

If In Slot #3
Comm. Port
Assignments
If In Slot #4

4/8

R T
C1
C2
R
M

C1

C2

RADIO

MODEM

OPTION
Populated
by
Order

1

2

MultiTech Modem Kit Parts
1 = Nylon Support Post
2 = MultiTech Modem Module

Cover Panel   **EMI Gasket**

R T
C1 ○○
C2 ○○
R ○○
M ○○

C1

C2

RADIO
J7

MODEM

TEXT ORIENTATION

1■ ○ JP2
○

1○○ JP1
1■○ JP4

J7   1⊖   J10

J6   **MultiTech**   J9
          Modem
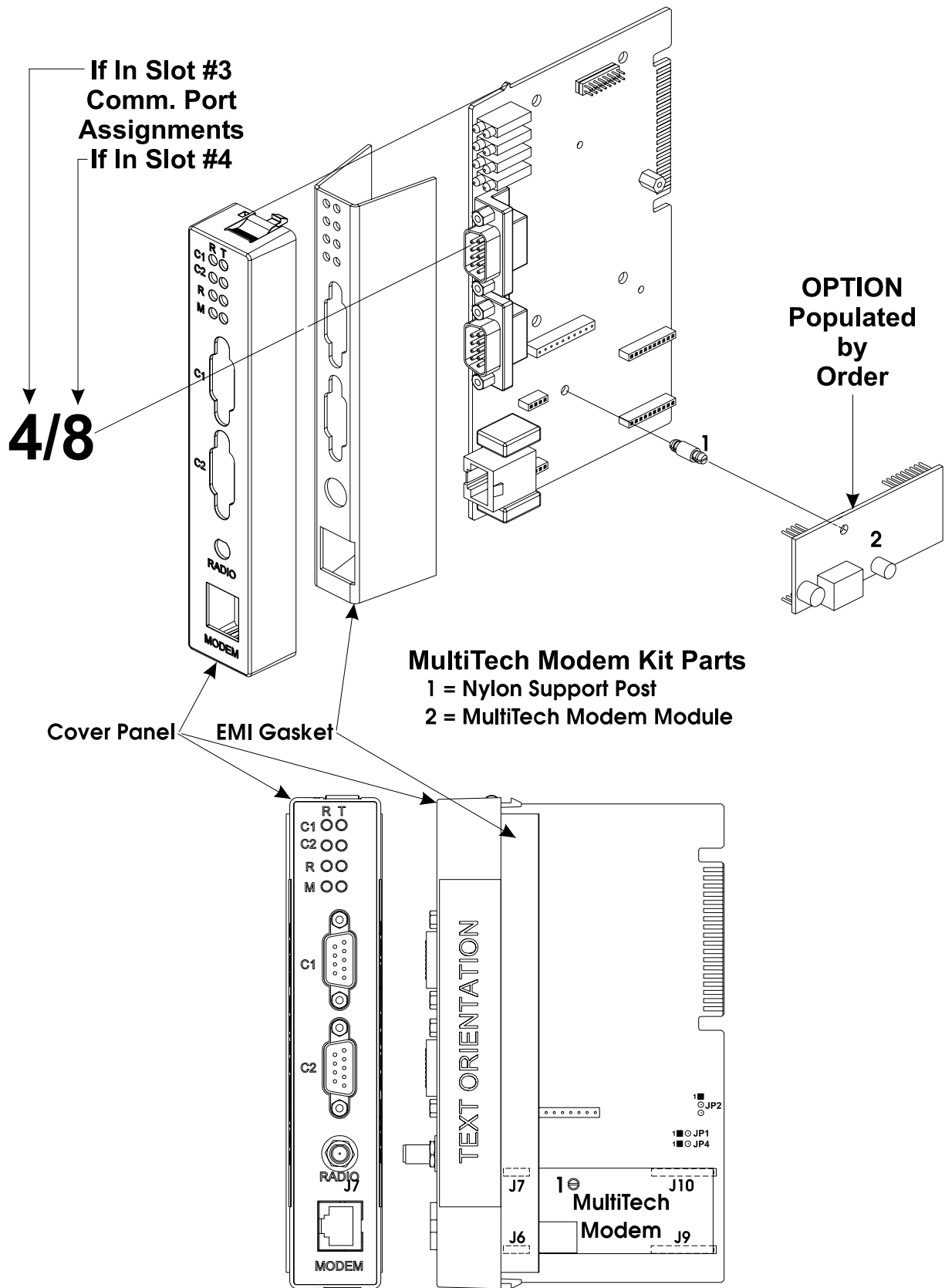
Figure D5 - MultiTech Modem Installation Diagram

6. Snap the Cover Panel onto the Expansion Comm. Module PCB and insert the ECOM Module into the appropriate Backplane Slot, i.e., Slot 3 or 4.

7. Apply power and test the unit.

D2.1.2 Configuring the MultiTech Modem (MT5634SMI)

To configure a Model MT5634SMI Modem (installed on an Expansion Communication Module), perform the following nine (9) steps:

1. If required, remove the Exp. Comm. Module from the unit in question (see Figure D1).

2. Place the modem into configuration mode by setting Expansion Comm. Module Jumper JP2 onto pins 2 and 3. This will enable configuration of the modem through Comm. Port 4 for modem on ECOM1 or through COMM. Port 8 for modem on ECOM2.

3. Connect a Full Duplex **Control**Wave Null Modem Cable (see Figure D3) between a PC and Comm. Port 4 (ECOM1) to configure modem on ECOM1 or Comm. Port 8 (ECOM2) to configure modem on ECOM2.

4. Open Hyperterminal on the PC and set the PC communication port settings as follows:

    Bits per second: 9600
    Data bits: 8
    Parity: None
    Stop bit: 1
    Flow Control: None

5. Send Factory Default = AT&F0.

6. Disable Flow Control = AT&K0.

7. Set baud rate using AT Command: AT$SB9600, or whatever baud rate you require.

8. Write to memory = AT&W.

9. Set Expansion Comm. Module Configuration Jumper JP2 into a storage position, i.e., parked (no connection).

ControlWave EFM/MICRO DISPLAY/KEYPAD ASSEMBLY - GUIDE
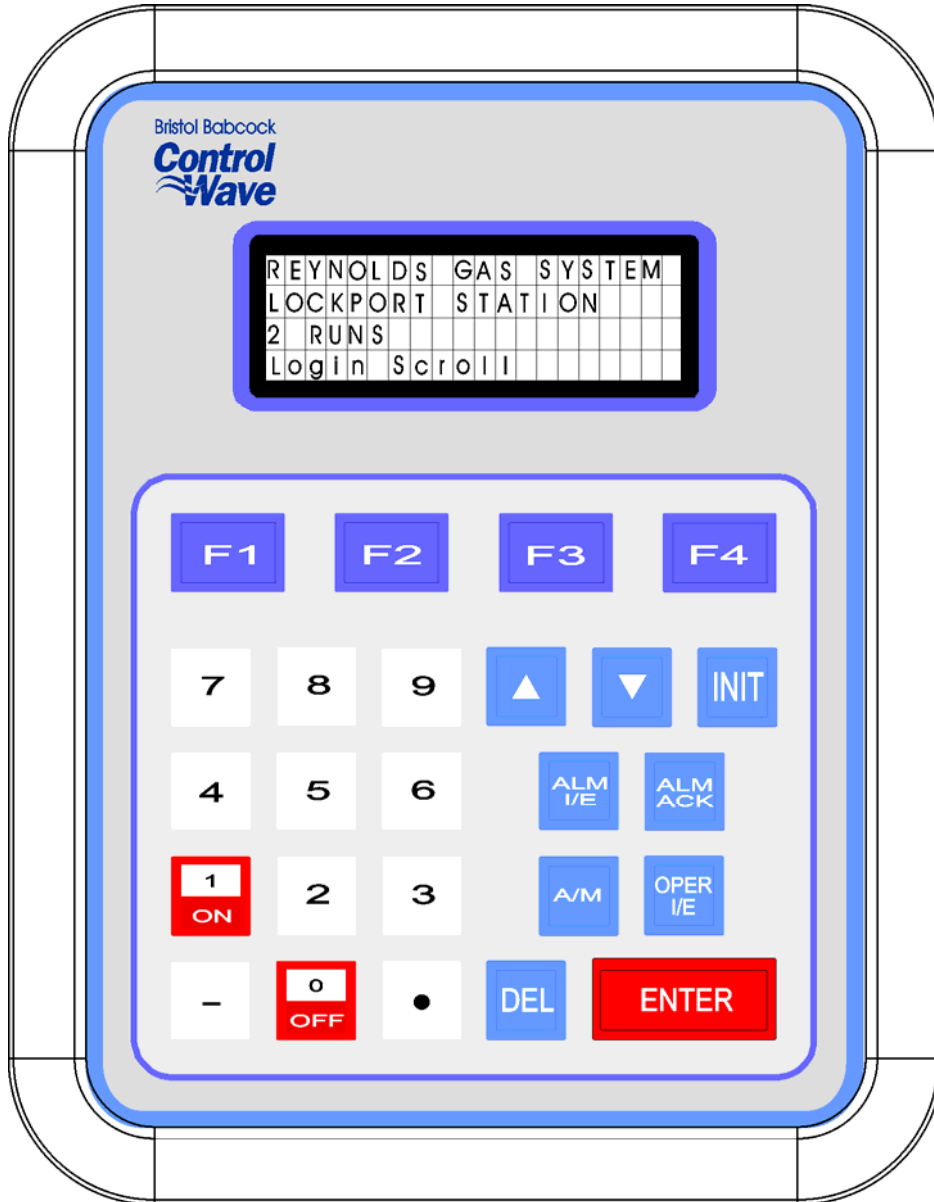
Appendix E

APPENDIX E

ControlWave MICRO/EFM Display/Keypad Assembly Guide

TABLE OF CONTENTS

Appendix E
DISPLAY/KEYPAD ASSEMBLY GUIDE

E1.1 OVERVIEW

Bristol, Inc. Display/Keypad assemblies provide a built-in, local, user interface for the **Control**Wave **MICRO** or the **Control**Wave **EFM**. These assemblies allow an operator or engineer to view and modify variable values and associated status information, via an ACCOL3 Function Block. Variables can include inputs, process variables, calculated variables, constants, setpoints, tuning parameters and outputs used in a measurement or control application. Status bits include alarm state, alarm acknowledge, control, manual, and questionable data.

Setting up the Display/Keypad is a simple matter of configuring a Display Function Block in the ControlWave Designer project.

The Display/Keypad is comprised of a four line by twenty character liquid crystal display, with adjustable LCD Contrast, and a 25 button membrane key matrix. Each key has a microswitch for positive tactile feedback. This means that as you firmly depress the keys, you will feel it click as it engages. In the case of the **Control**Wave **EFM**, the Display/Keypad is located in the Instrument Front Cover and is installed at the factory.
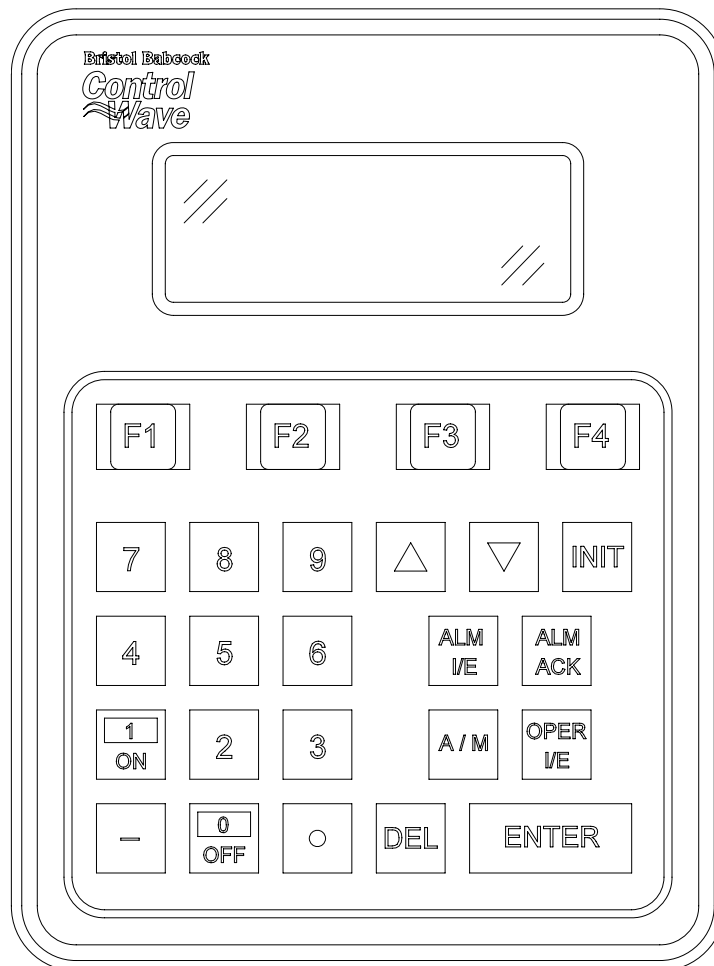
Figure 1 - Display/Keypad Assembly – 25 Button Keypad & 4 X 20 Display

Display/Keypad Assemblies are supported by **Automatic Mode and Manual Mode**.

Automatic Mode
In Automatic Mode a set of screens (based on the application load) are displayed. The application programmer provides strings for the opening screen. From there the firmware is responsible for displaying the screens and responding to key presses. Screens are fixed and start off with an opening screen, which displays user information passed into the function block. Users can view a list to select which list is to be scrolled. Once the list to be scrolled has been selected, the user can scroll through the list by pressing the down arrow key. List elements will be displayed automatically, scrolling at a predetermined rate (determined by iiScrollTime). The user may pause on a variable by pressing the right arrow key. Pressing the right arrow key again will cause the list to start scrolling again.

The essence of Automatic Mode is that the user can supply inputs into the function that will determine which list can be displayed, but cannot change the menu or display. The user is allowed to select a list and to start/stop scrolling.

Manual Mode
In Manual Mode the programmer is responsible for creating each screen and displaying the next desired screen, based on key inputs. The programmer has access to all lines of the display and can provide any string that he/she desires to display. Special formats that must be adhered to that allow the programmer to display what they want on the screen are provided in the description of iaScrnSruct in the ACCOL 3 Display function block within ControlWave Designer's On-Line Help. It should be noted that currently, Manual Mode does not support reading Keypad keypresses. **Note: Manual Mode operation requires ControlWave Firmware 4.50 or newer.**

If you're setting up the keypad, follow the configuration instructions provided in Section E3 of this appendix.

If your keypad has already been set up, Section E4 will tell you how to use the keypad and interpret the display.

E2.1 DISPLAY FUNCTION BLOCK DESCRIPTION

Keypad and display control/configuration are handled by the DISPLAY Function Block. This function block allows an operator to view/change variable data or to be allowed to scroll through lists of variable data based upon their login privileges.

In order for the keypad and display to operate, the ControlWave Designer project must include a properly configured DISPLAY Function Block. Use ControlWave Designer to configure this function block and assign the parameters according to the four steps covered in Section 3.

E2.1.1 DISPLAY Function Block Parameters

Referring to Figure 2, various DISPLAY Function Block Parameters are available. For information on configuring the Display Function Block, please reference on-line help in ControlWave Designer.
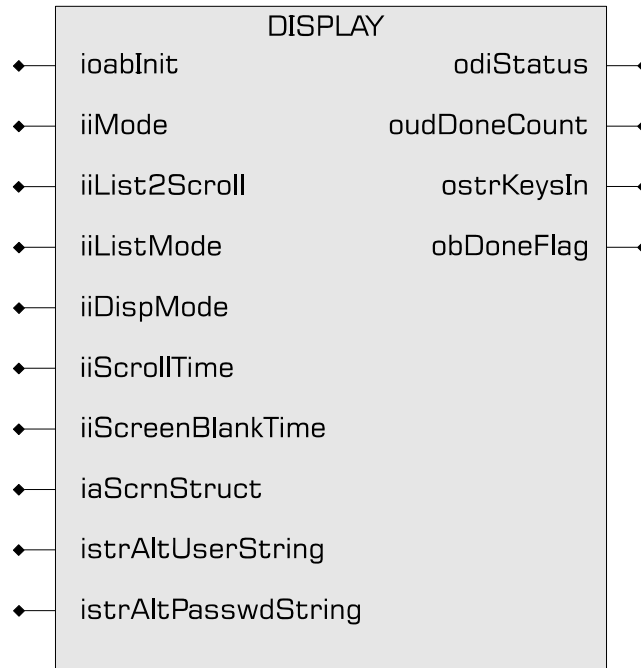
```
                    DISPLAY
  ◆──  ioabInit                      odiStatus  ──◆

  ◆──  iiMode                  oudDoneCount  ──◆

  ◆──  iiList2Scroll                ostrKeysIn  ──◆

  ◆──  iiListMode               obDoneFlag  ──◆

  ◆──  iiDispMode

  ◆──  iiScrollTime

  ◆──  iiScreenBlankTime

  ◆──  iaScrnStruct

  ◆──  istrAltUserString

  ◆──  istrAltPasswdString
```

Figure 2 - ACCOL3 DISPLAY Function Block Parameters

E3.1 PREPARING THE ControlWave PROJECT

In order for the keypad and display to operate, the ControlWave Designer project must include a properly configured Display Function Block. Once the Keypad is operating, a user who has signed on with a password can scroll through the names of variable lists and choose a list to read or change. Use Up Arrow and Down Arrow keys to select the Username and use the numeric keys to enter your password. The steps that follow describe how to configure this function block.

Step 1: Creating the Identifier Display

The Identifier Display is the first display to appear when the Display Function Block is initialized and begins to execute. This display will look similar to Figure 3. Each of the first three lines of the display contains the text value of a string variable. These string variables are created utilizing iaScrnStruct parameters of the Display Function Block (See Figure 2) and your computer keyboard. Since this is the first display that the user will see, you may want the display to contain general information such as the node name of the controller or the process that the controller is monitoring.

The bottom line on the display is called the legend line. It shows which function keys are currently active and their purpose. Function keys are those keys on the Keypad that are marked ([F1] through [F4]). Function key assignments are preconfigured and cannot be changed. Using function keys is described in Section 4, Using the Keypad.

The legend line in Figure 3 shows that the user has two choices: to Log-in (using [F1]) or scroll (using [F2]).
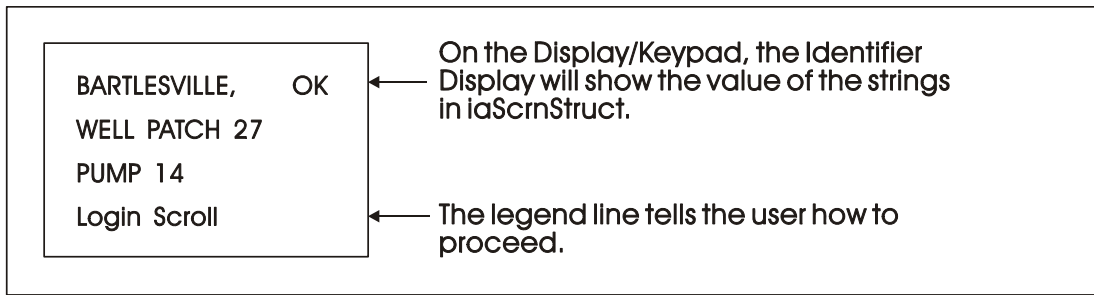
Figure 3 - Creating the Identifier Message

Step 2: Defining a Scroll List

Once the keypad is operating properly, you can automatically scroll through a list of variables created via DISPLAY Function Block Parameters <u>iiList2Scroll</u> and <u>iiListMode</u>. Scrolling can be done without entering a password. The variables in the list are displayed one at a time and in the same order in which they were entered in the variable list.

Later, we'll discuss other variable lists that can be accessed with the keypad. To distinguish this list from others, let's call this variable list the Scroll List.

Enter the number of a variable list to be scrolled. This variable list becomes the Scroll List. The Scroll List can contain different types of variables (that is, logical, analog and string). You can create a specific scroll variable list or use any list in the ControlWave Project.

Each variable in the Scroll List will be displayed for the number of seconds defined by the iiScrollTime parameter. If you don't specify a time for this parameter, the hold time will be two seconds. If you signed-on and then started scrolling you will be signed-off in 20 minutes if no keys are pressed. If you don't want to automatically stop scrolling after 20 minutes, sign-off (INIT key) before starting scrolling.

Step 3: Assigning Passwords

A valid RTU username/password combination must be entered to go beyond the initial displays. Passwords can be any combination of numbers up to 16 digits in length, from 0000000000000000 to 9999999999999999. If none are specified, the default values are <u>system</u> for User-name and <u>666666</u> for Password (read/write access).

Step 4: Status Information

Enter a variable name on the odiStatus terminal.

See On Line Help in ControlWave Designer for Status Values.

The next section describes how to use the Keypad to access variable information.

E4.1 USING THE KEYPAD

The Identifier Display is the starting point from which you can go to other displays. It shows an identification message and the words <u>Login</u> and <u>Scroll</u> at the bottom of the screen (see Note 1). The identification message may contain the name of the controller, the plant equipment it is monitoring, or the variables you can expect to see when you use this display.

Note 1 : *If your display shows something else, press the [F4] key until you see the words* <u>*Login*</u> *and* <u>*Scroll*</u> *on the bottom line.*

If your screen is blank, turn the brightness screw clockwise. This screw is located to the left of the Keypad (looking at the rear of the 25-Button Display/Keypad Assembly (see Figure 17). If no letters appear, the controller has not been programmed properly to operate the keypad.

The words Login and Scroll at the bottom of the screen are on the legend line. It tells you which function keys (that is, key [F1] through [F4]) are active and their purpose at that time.

Up to four legends can appear on the legend line. The legend on the far left corresponds to the function of the [F1] key. The assignment for the [F4] key is on the far right. Keys [F2] and [F3] are described to the left and right of center. When no legend appears, that function key is not active at that time. For example, in Figure 4 only [F1] and [F2] are active.
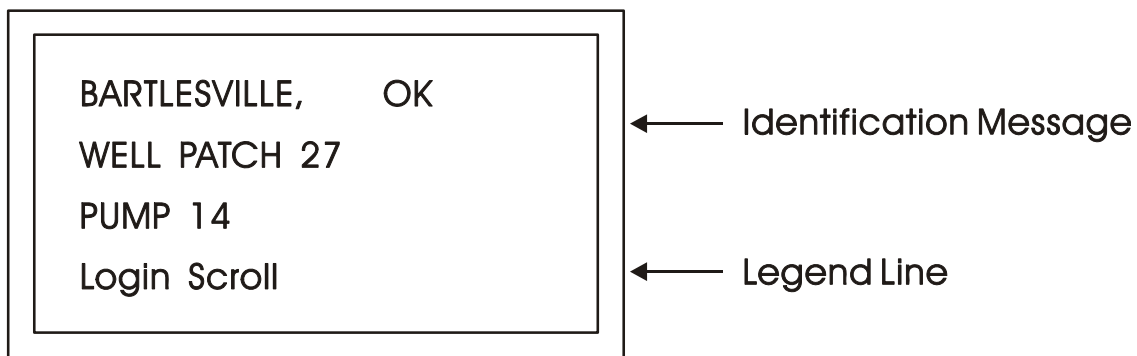
Figure 4 - The Identifier Display

From the Identifier Display, you have two choices. Pressing [F1] will allow you to sign-on if you have a password. By pressing [F2] you can activate automatic scrolling through a list of variables.
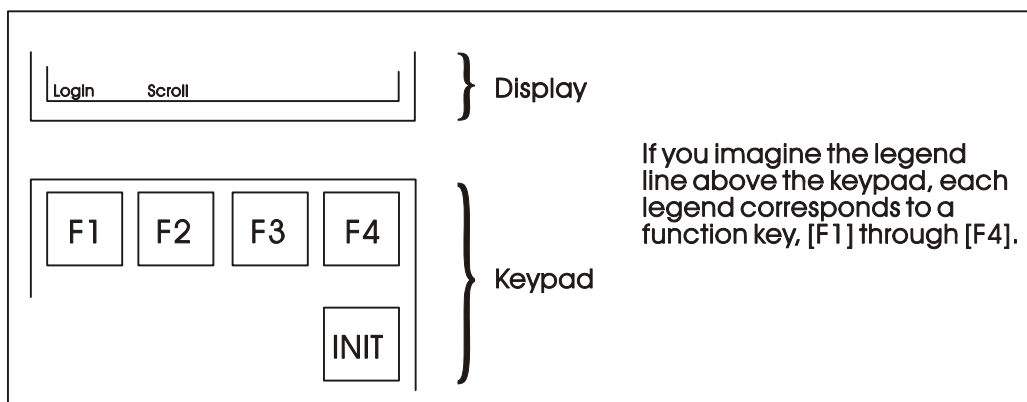
Figure 5 - Identifier Display Legends and Corresponding Keypad Alignment for 25 Button Membrane Key Matrix Keypad System

E4.1.1 Scrolling

To begin automatic scrolling, press [F2] from the Identifier Display (Figure 4). Variable information will appear on the screen and remain there for 1 to 30 seconds (default = 2). The

variable name appears on the first line. The variable value appears on the second line and status information appears on the third line. An example is shown in Figure 6.

When all variables in the list have been displayed, they will be shown again in the same order. This is called Single Variable Mode.

Pressing Mlti [F2] activates Multiple Variable Mode. Multiple Variable Mode displays up to three (3) variables and their values on the screen simultaneously. Pressing Sngl [F2] terminates Multiple Variable Mode and returns you to Single Variable Mode.

<table>
<tr>
<td>
TOTAL_MCF

437052.3

     CE ME AE NA

Hold Mlti   Exit
</td>
<td>
TOTAL_MCF   437052.3

VAR2   VAL

VAR 3   VAL

Go Sngl   Exit
</td>
</tr>
<tr>
<td align="center">Single Variable Mode</td>
<td align="center">Multiple Variable Mode</td>
</tr>
</table>
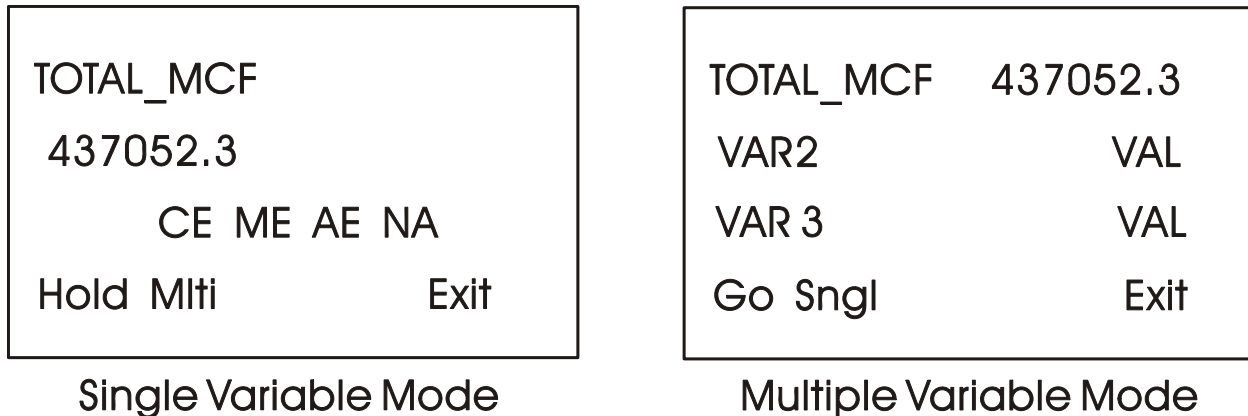
Figure 6 - Scrolling

Press HOLD [F1] to halt scrolling. Changing variable values will continue to be displayed.

Press GO [F1] to resume scrolling.

Press EXIT [F4] to return to the Identifier Display (Figure 4).

E4.1.2 Signing-On

To access the List Menu, you must first sign-on with a proper password. From the Identifier Display (Figure 4), press [F1]. The screen will look like Figure 7A or 7C. If the display looks like Figure 7C:

>   Someone else has already signed on. Go to the paragraph below that starts "Once you have successfully signed on,…".

If the display looks like Figure 7A:

>   Select the Username (default = system) by using the Up and Down Arrow Keys. If the Username system is displayed and no other Username is available (i.e., no others have been assigned), press [ENTER].

>   Enter a password using the 0 to 9 keys. For security, asterisks will appear as you enter the digits. If you make a mistake, press [F1] and try again (or use the delete key to delete the previously pressed key action). The default password is 666666 (used when a password is not known or no password has been assigned). After typing the password, press [ENTER].

>   If your password is not recognized, the asterisks will be erased after you press [ENTER]. Check your password and try again.

```
┌─────────────────────────────────┐          ┌─────────────────────────────────┐
│ Username:          System       │          │ Username:          System       │
│                                 │          │ Password:                       │
│                                 │          │ ******                          │
│                         EXIT    │          │                         EXIT    │
└─────────────────────────────────┘          └─────────────────────────────────┘
```

Figure A
Login Display

The display is ready to
select username.

Figure B
Enter Password Display

Key your password in numerically.

```
            ┌─────────────────────────────────┐
            │ Logged-On With                  │
            │ Read Only Access                │
            │                                 │
            │ Clk     Menu     Scrl    Exit   │
            └─────────────────────────────────┘
```

Figure C
Logged-On Display

When your password is accepted,
the display will indicate either
READ ONLY or READ/WRITE Access.
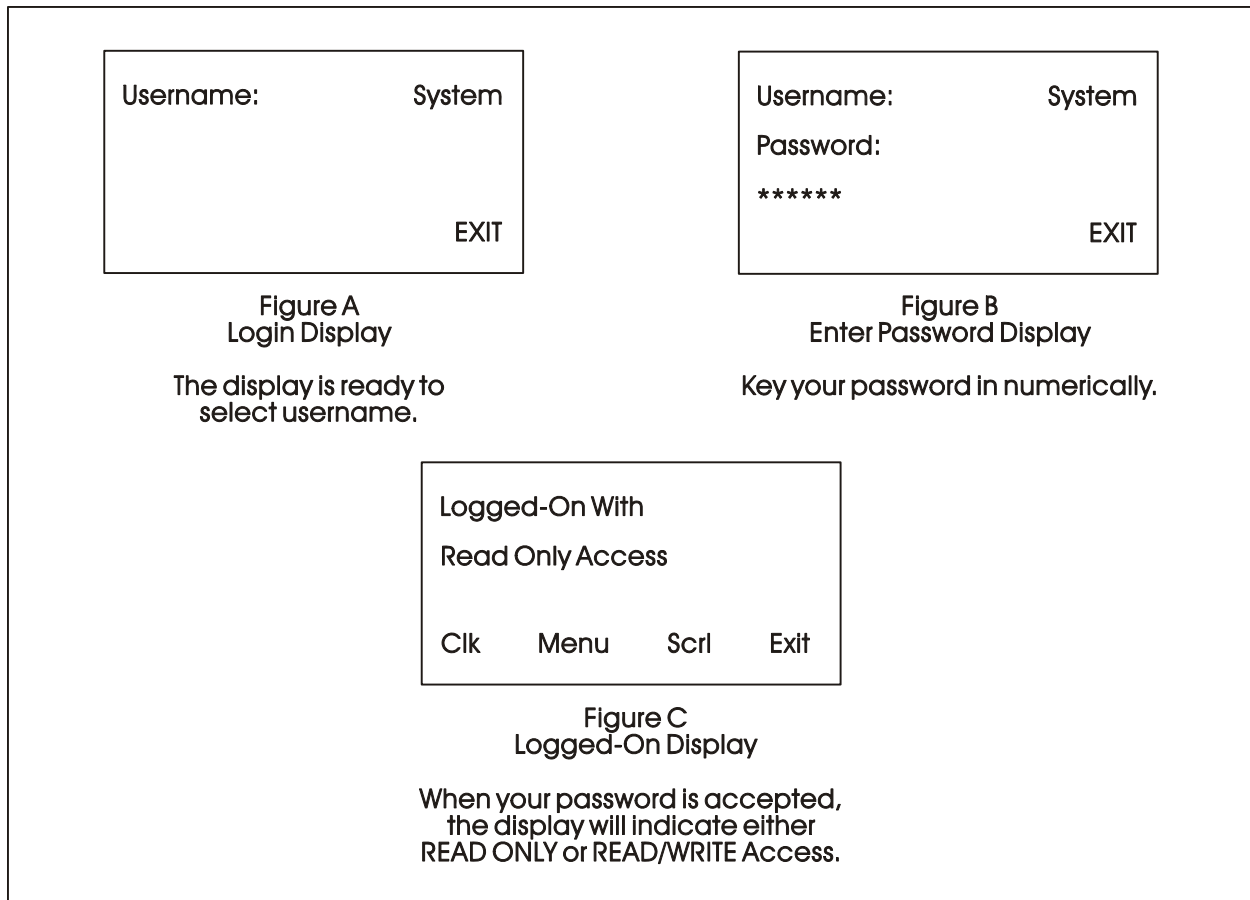
Figure 7 - Logging On

Once the correct password has been entered, the display will look like Figure 7C.

When the second line shows READ/WRITE, you can read and write variable parameters. When it shows READ ONLY you cannot change variable parameters. You are only permitted to read variable information. If your display shows READ ONLY and you want to change variable values, sign-off (press the [INIT] key) and log on with a username and password that provides Read/Write privileges.

Once you have successfully signed on, the legend line will show that you have four options. You can view and change the time and date of the local clock, access more variable lists, Scroll, or return to the Identifier Display. Use function keys F1 through F4 to select the next menu (F1 = Clock, F2 = Menu, F3 = Scroll list & F4 = Exit). Let's start by setting the local clock.

E4.1.3 Using the Clock Functions

From the Logged-On Display (Figure 7C), press [F1]. The screen will show the present date and time and will look like Figure 8. Follow the instructions below to change the time or date. When you're finished, press [F4] to exit.

Today's date is shown in the first line in the format month/day/year.

The current time is shown in the form of hours:minutes:seconds.

```
┌─────────────────────────────┐
│                             │
│   09/30/2004                │
│   11:47:42                  │
│                             │
│                             │
│   Date  Time        Exit    │
│                             │
└─────────────────────────────┘
```
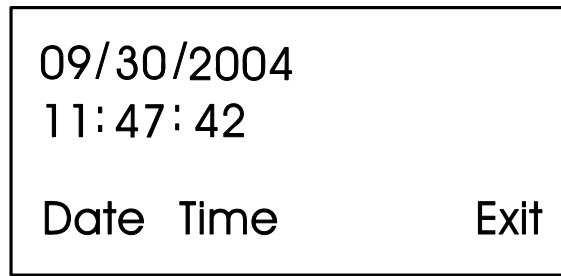
Figure 8 - Clock Display

E4.1.3.1 Changing the Time

From the display shown in Figure 8, press Time [F2]. Colons (:) will appear on the third line. Enter the new time there and press [ENTER]. Valid times range from 00:00:00 to 23:59:59. Invalid entries will be ignored. The display will be updated to show the new time.

```
┌─────────────────────────────┐
│                             │
│   09/30/2004                │
│   11:47:42                  │
│      :    :                 │
│   Date  Time        Exit    │
│                             │
└─────────────────────────────┘
```
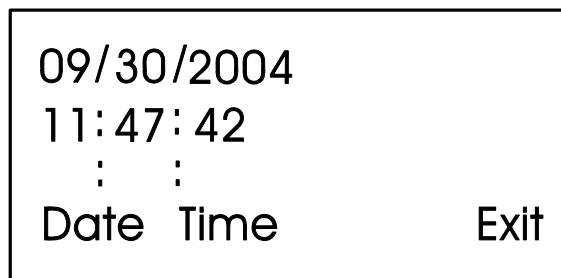
Figure 9 - Time Set Display

If you make a mistake while entering the new time, use [DEL] to backspace and delete one character at a time.

E4.1.3.2 Changing the Date

From the clock display (Figure 8, press [F1]. Slash marks (/) will appear on the third line. Enter the new date there and press [ENTER].

```
┌─────────────────────────────┐
│                             │
│   09/30/2004                │
│   11:47:42                  │
│      /    /                 │
│   Date  Time        Exit    │
│                             │
└─────────────────────────────┘
```
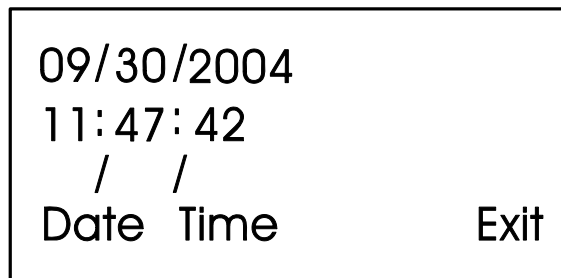
Figure 10 - Date Set Display

If you make a mistake while entering the new date, use [DEL] to back space and delete one character at a time. Press [F4] to return to the Logged-On Display (Figure 7C).

E4.1.4 Choosing a Variable List from the List Menu

The List Menu is another area where variable information can be seen. As explained earlier in this section, your first opportunity to read variable information is by choosing the

SCROLL function from the Initial Display. The variable name and value are presented from the Scroll List. This function is available to all users even without signing-on.

The List Menu will show other groups of variable which you can choose to read. This information will be more detailed than the Scroll List.

To get to the List Menu, choose MENU (press [F2]) from the Logged-On Display (Figure 7C).


```
LIST NAME
LIST CHOICE: 10          On the List Menu Display, with the
                         number 10 displayed, ENTER is pressed.
Prev   Next        EXIT


 SELECTED  LIST = 10
 CONFIG.001              The resulting display will look
                         like this.
 Read   Write   Scrl   EXIT
```
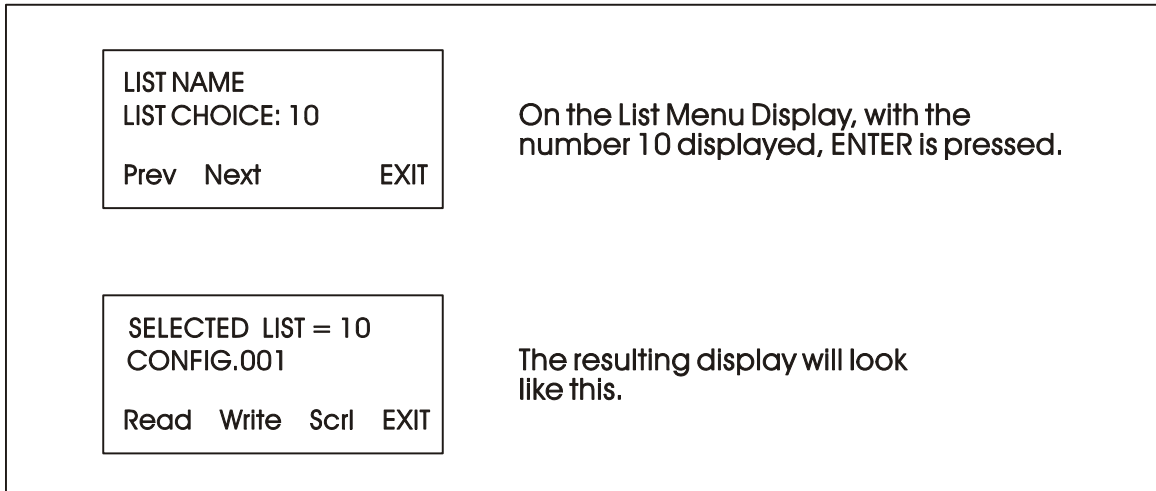
Figure 11 - Using the List Menu Display

The first variable list number in the menu will appear on the second line.

Press PREV (F1) and NEXT (F2) to see the other variable lists that are available in the List Menu. You can also use the Up and Down Arrow Keys to scroll through the various lists. To move directly to a list, enter the list number, then press [ENTER].

E4.1.5 Moving Through a Variable List

After READ (F1) or WRITE (F2) has been pressed, the display will show the first variable in the list. An example is shown in Figure 12. Each time NEXT (F2) is pressed; the display will show the next variable in the list. PREV (F1) will show the previous variable. You can also use the Up and Down Arrow Keys to move through a list.

Automatic wraparound occurs in either direction. When you reach the end of the list, [F1] will display the first variable again. At the top of the list, [F2] will display the last variable.

E4.1.6 Changing Variable Parameters

From Figure 11, you can change variable parameters by pressing F2 [Write]. Then follow the directions summarized below (see Note 2).

Note 2: If your display does not contain the legend Write in the legend line, your password will only allow you to read variables. If you want to change variable values at this time, you must first log-off and then log-on using the correct password. See your Systems Engineer for the correct password.

Before making any changes, first check the signal inhibit status field (See Figure 12). When the display shows ME (manual enable) you can change variable parameters. When it shows MI (manual inhibit), you cannot alter the parameters of this variable. If the field indicates MI, press the OPER I/E key to change it to ME.

To change an analog value:

Press CHNG (F3) to clear the third line. Use the number keys 0 through 9 to enter the new value. The minus sign and period are also permitted. Press [ENTER].

If you make a mistake, press CHNG (F3) and enter the number again or use the [DEL] key to erase a character.

Another way to enter new values is by using the arrow up and arrow down keys (located below the [F3] key and left of the [INIT] key). These keys will raise and lower the value by 1% of the displayed amount.

To change the status of a logical variable:

Press CHNG (F3), then use either the down and up arrow keys or the [0/OFF] and [1/ON] keys to change the state of a logical variable. If the [0/OFF] and [1/ON] keys are used, you must also press [ENTER].
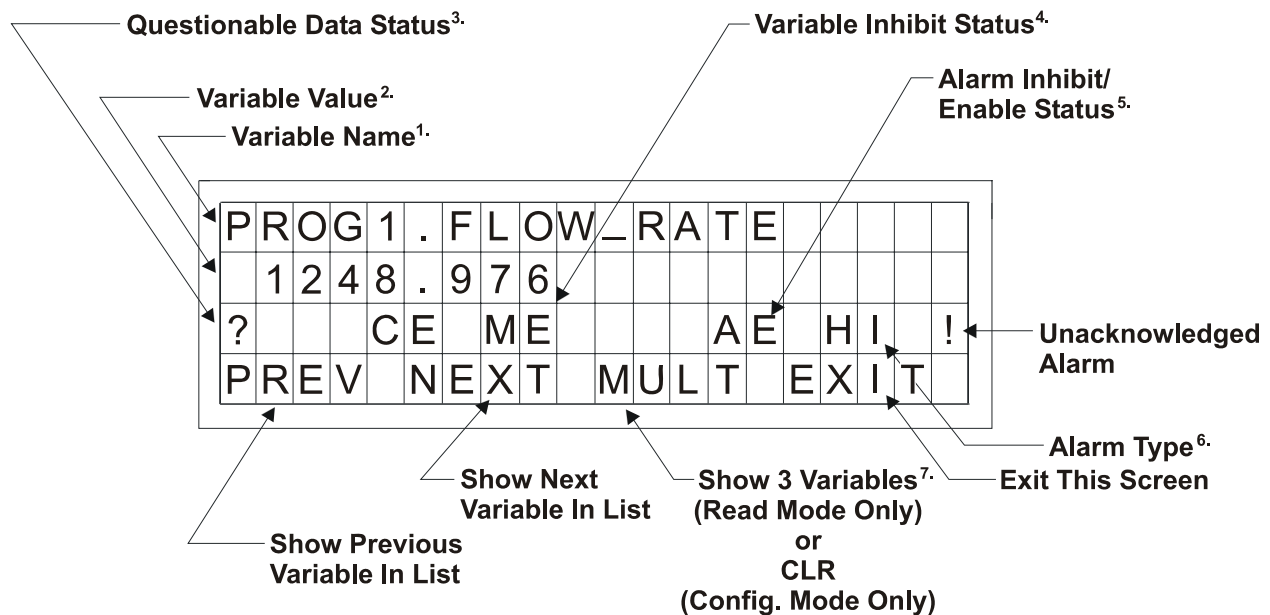
Figure 12 - Interpreting Variable Information

To acknowledge an alarm:

Press [ALM ACK].

To change the alarm enable/inhibit status for alarm variables:

Press [ALM I/E] key. (Note: This will only inhibit alarm reporting, and not alarm level detection.)

Notes for Figure 12

1. Variable Name (Example 1: @GV.FLOW_RATE) (Example 2: @GV.TOTAL_FLOW_RATE)

2. Value - analog value, string value, or logical value. Values which cannot fit in this field will be shown as asterisks.

    Analog values are displayed in floating point format, for example, 0.0125, 99.627, and 1287.66. When the value cannot be shown in floating point format, scientific format is used (1.287668E+10 or 1.25E-02 for example).

3. Questionable Data Status - for analog variables, column 1 will be clear if the status is valid. It will display a question mark if the status is questionable.

4. Variable Inhibit Status

    CE (Control Enable) means this variable can be updated by the ControlWave project.
    CI (Control Inhibit) means the variable cannot be updated by the ControlWave project.
    ME (Manual Enable) means the variable can be changed manually.
    MI (Manual Inhibit) means the variable cannot be changed manually.

5. Alarm Enable (for alarm variables only)

    AE - variable is alarm enabled (changes will be reported).
    AI - variable is alarm inhibited (changes will not be reported).

6. Alarm State

    For Analog Variables: For Logical Variables:
    HH   - high-high alarm   TA   - true alarm
    HI   - high alarm   FA   - false alarm
    LO   - low alarm   CA   - change-of-state alarm
    LL   - low-low alarm

    ! - alarm is unacknowledged

7   Multiple Signal Display

    In Read Mode, pressing MULT (F3) will display the variable name extension, value, and units for three variables at one time. These variables include the variable displayed when NEXT (F2) was pressed and the next two variables in the list. Press SNGL [F3] to return to viewing one variable at a time (see Figure 12A).

N	A	M	E			W	E	S	T		S	U	N	B	U	R	Y		P
F	L	O	W				1	2	6	0	.	5	8	G	A	L	S	.	
A	L	A	R	M			O	F	F										
P	R	E	V		N	E	X	T		S	N	G	L		E	X	I	T	

Figure 12A - Example of MULT Display in READ Mode

Notes for Figure 12 (Continued)

Variables are shown below as they would appear in SNGL mode.

1) String
      SITE_NAME
      WEST SUNBURY PUMP STATION
            CE ME

2) Analog
      TOTAL_FLOW_RATE
        1260.578
            CE MI

3) Logical
      FLOW_ALARM
      OFF
            CE MI AE NA

E4.1.7 Signing-Off

Once you have logged-on, use the [INIT] key at any time to log-off. When this key has been pressed, the screen will look like Figure 13. Press Yes (F1) to sign-off. You are signed-off when the Identifier Display (Figure 3C) appears.

If you do not want to log-off, press Exit (F4) to leave the Log-Off Display.

Once you are signed-on an automatic sign-off will occur if 20 minutes has elapsed since the last key was pressed.

```
 ┌─────────────────────────────────┐
 │                                 │
 │   LOG-OFF?                      │
 │                                 │
 │                                 │
 │                                 │
 │   Yes   No            Exit      │
 │                                 │
 └─────────────────────────────────┘
```
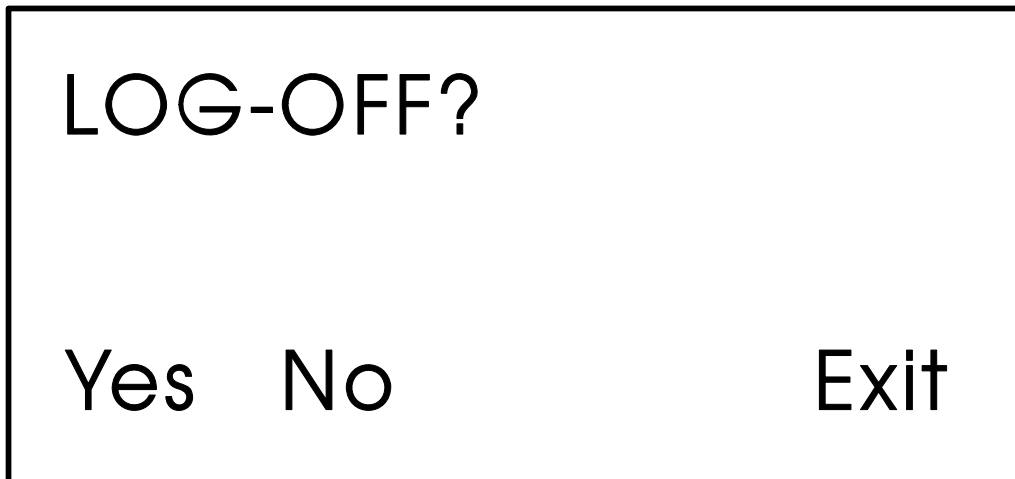
Figure 13 - Log-Off Display

E5.1 KEYPAD IDENTIFICATION & INSTALLATION INFO.

A = Screw (Qty. 4)
B = Display/Keypad Sub-Ass'y.
C = .563" F/F Standoff (Qty. 4)
D = Washer (Qty. 4)
E = User Mounting Panel/Plate/Front Cover
F = Display/Keypad Front Plate
G = #4 Washer & Nut (Qty. 2)
H = Brightness Adj. Pot.

**DISPLAY/KEYPAD ASS'Y.
BACK VIEW**

**BACK VIEW
PLATE DIMENSIONS**

Figure 14 – 25 Button Display/Keypad Assembly Installation Drawing

Figure 15 - 25 Button Keypad

Table 1 - 25 Button Keypad Keys

KEY	FUNCTION
F1, F2, F3, F4	Function keys will take on a variety of different functions depending on the situation. The function of these keys is listed on the legend line (bottom line) of the display.
INIT	The INIT key is used to terminate the keyboard session and sign-off.
0 to 9, -, •	These keys are used to change the value of analog variables in the CONFIGURATION mode. The 0/OFF and 1/ON keys are used to change the state of logical variables.
Δ	Each press of this key will raise an analog variable value by 1% of the displayed value or turn a logical variable ON.
∇	Each press of this key will lower an analog variable value by 1% of the displayed value or turn a logical variable OFF.
ALM I/E	Use this key to enable or inhibit alarm variables.
ALM ACK	Use this key to acknowledge alarms.
A/M	Toggle between AUTO (CE) and MANUAL (CI) with this key.
OPER I/E	Toggle between manual inhibit (MI) and enable (ME) with this key.
DEL	Use this backspace key to erase digits that have been entered on the keypad.
ENTER	This key is used to enter new data from the display into the controller, e.g., password or variable values.

Using ControlWave EFM *WebBSI* Web Pages

Appendix F

APPENDIX F

ControlWave EFM
Using ControlWave EFM
WebBSI Web Pages

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APPENDIX F

Control$W$ave EFM
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WebBSI Web Pages

TABLE OF CONTENTS

Appendix F
Using **Control**Wave **EFM**
WebBSI Web Pages

F.1 GENERAL OVERVIEW

The **Control**Wave **EFM** is configured and monitored using WebBSI Web pages developed specifically for the standard application program. The Web pages are stored and displayed on a personal computer (PC), and use either OpenBSI Network edition or Local edition to interface to the **Control**Wave **EFM**. Web pages provide:

>   * *Sign-on to the* **Control**Wave **EFM** *(CW EFM)*
>   * *Invoke menus to configure the* CW EFM *for operation*
>   * *Read current gas flow and total information*
>   * *Set the* CW EFM *Date and Time*
>   * *Change the* CW EFM *network address*
>   * *Collect & Display the Daily, Hourly, Periodic, & Audit Logs*

F.1.1 Viewing WebBSI

WebBSI is best viewed under these conditions:

- The Internet Explorer window be maximized or be viewed full-screen.
- The resolution of the monitor be at least 800x600 or above (preferably 1024x768 or above).
- The color depth can be at least 16 bit high color or above (preferably 24 bit true color or above).
- The text size of Internet Explorer be "Medium" or smaller (preferably "Medium").
- JavaScript and ActiveX Controls be enabled in Internet Explorer.

Pop-up Help windows for WebBSI Web pages can be accessed by clicking the Help button on the left side of WebBSI Web pages. The help windows must be closed in order to open another.

On pages that contain tables of controls:

- A white background on a control means that it is read/write.
- A beige background on a control means that it is read only.

NOTE: Web pages may appear slightly different than those displayed herein!

F.2 INSTALLING WebBSI SOFTWARE & ControlWave EFM Web Pages

The WebBSI software requires a PC (computer) running either OpenBSI Network Edition or OpenBSI Local Edition, with the WebBSI ActiveX controls installed and registered on the PC (see appropriate document for details).

ControlWave **EFM** Web pages will be installed in the following directory as the default: C:\OpenBSI\CWEFM\ and the default startup page will be CW_MICRO_EFM.htm

ControlWave EFM

PC/Laptop Computer

ControlWave EFM

WebBSI

MENU

SYSTEM
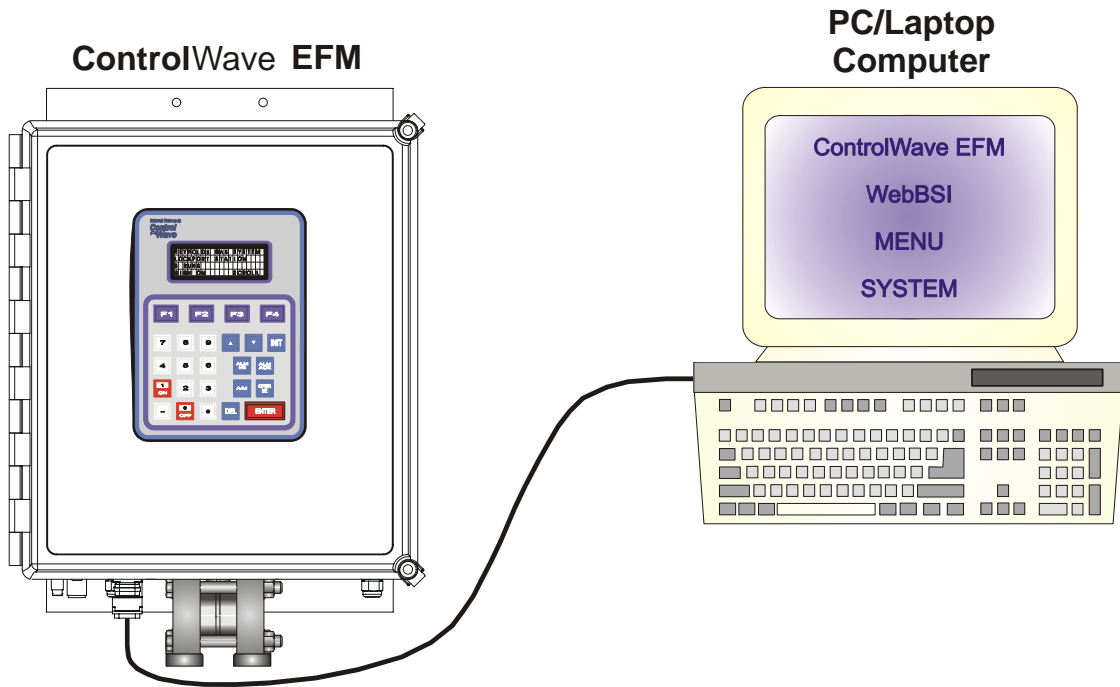
Figure F-1 - Control Wave **EFM**
Connected to PC via the Local Communications Cable

F.2.1 Communication Connections

The **Control**Wave **EFM** communicates with the PC through the Local Port as shown in Figures F-1 through 2B. The Local Port has been provided specifically for installation, startup and on-site configuration and data collection.

For ControlWave EFM's equipped with a D-type Local Port, local communications between the **Control**Wave **EFM** and the PC is provided over a standard **Control**Wave null-modem cable (see Figure F-2A). Units equipped with the circular 3-pin Local Port utilize a special cable as illustrated in Figure F-2B.

COMPUTER

5	5 = GND	To P2 Pin-5
9	4 = DTR	To P2 Pin-6
8 = CTS	3 = TXD	To P2 Pin-2
	7 = RTS	To P2 Pin-1
	2 = RXD	To P2 Pin-3
6	6 = DSR	To P2 Pin-4
1	1 = DCD	To P2 Pin-7

9-Pin Female "D" Connector

(Looking into Wire Terminal Side of Cable Connectors)
or vice versa

ControlWave **EFM**

CPU Module
Comm. Port 1
Is Connected
to the Local Port
via a 1-to-1 Cable

Local Port
(Comm. Port 1)
Bottom of Enclosure

1 = DCD	1
6 = DSR	6
2 = RXD	
7 = RTS	
3 = TXD	
8 = CTS	
4 = DTR	
	9
5 = GND	5

9-Pin Female "D" Connector

Figure F-2A - Control Wave **EFM (with D-type Local Port)**
Null Modem Cable (Bristol P/N 392843-01-3) Connection Diagram
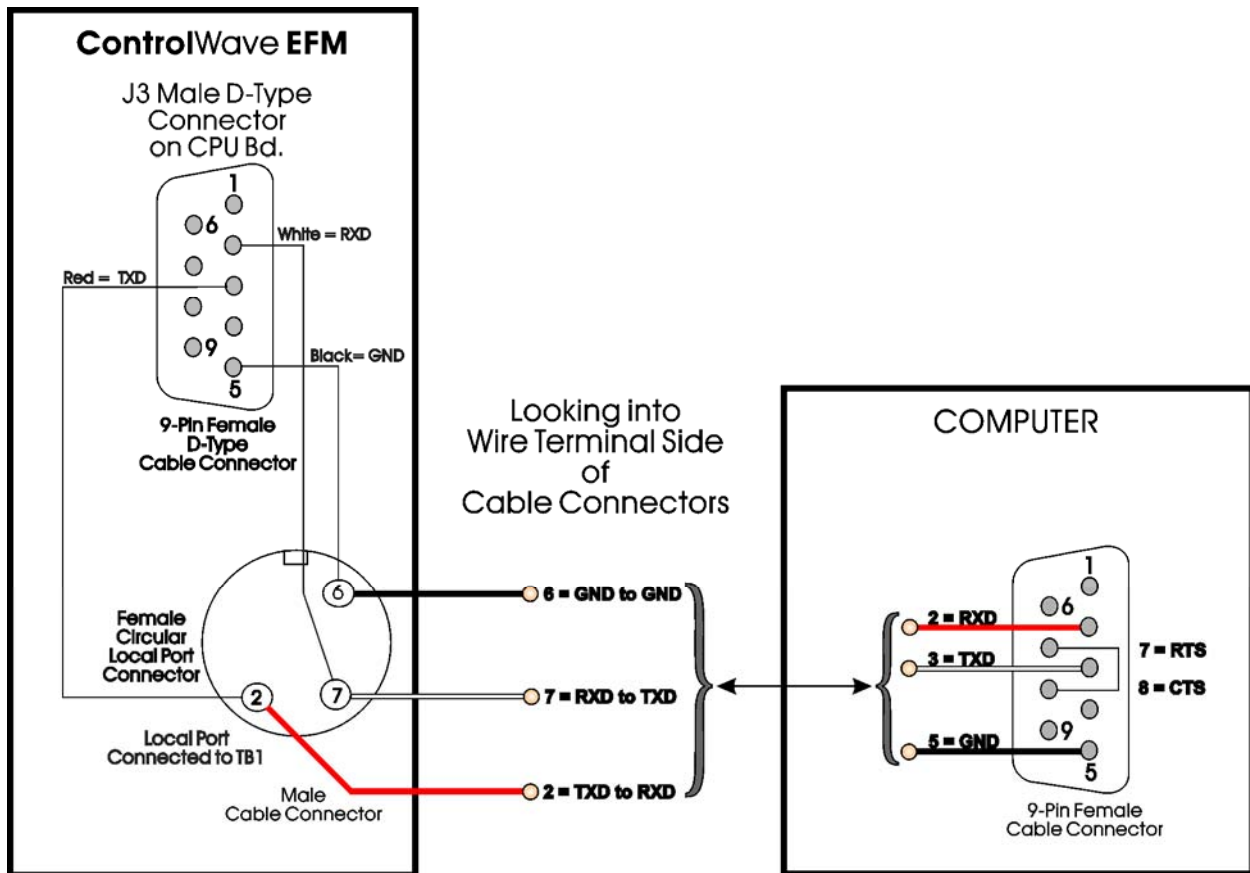
Figure F-2B - PC Connected to ControlWave EFM (via Circular Local Port)
Bristol Cable Part Number 395402-01-8 = 10 Foot Comm. Cable
Bristol Cable Part Number 395402-02-6 = 25 Foot Comm. Cable

F.3 WebBSI PROGRAM STARTUP

Ensure that the Local Communications Cable connections (at both the **Control**Wave **EFM** & the PC) are secure.

If the WebBSI Web pages for the **Control**Wave **EFM** have been assigned as the default Web pages for a node in OpenBSI, they can be invoked either from OpenBSI by right clicking on the appropriate RTU and selecting RTU -> WebPage Access. Web pages are also accessible by selecting Start -> Programs-> OpenBSI Tools-> WebPage Access -> CW EFC Pages.

Six Category Functions are provided as follows:

Section F.4 (Security)   Section F.7 (Chromatograph)   Section F.10 (Special Functions)
Section F.5 (Station)   Section F.8 (Logs)
Section F.6 (Meter Run)   Section F.9 (Load/Save)

F.4 SECURITY CATEGORY FUNCTIONS

Three Web pages are accessible from the Security category section of WebBSI.

- Sign On/Off   (Section F.4.1)
- Contacts   (Section F.4.3)
- Locate Nodes   (Section F.4.2)

F.4.1 Signing On/Off

When the WebBSI Web pages for the **Control**Wave **EFM** are first accessed, the **SIGN On/Off** Web page is displayed. A user must select the RTU Name from the drop down menu. If using OpenBSI Network Edition, this drop down menu will include all nodes available on the network. If using OpenBSI Local Edition, only the default node (RTU) will be available.
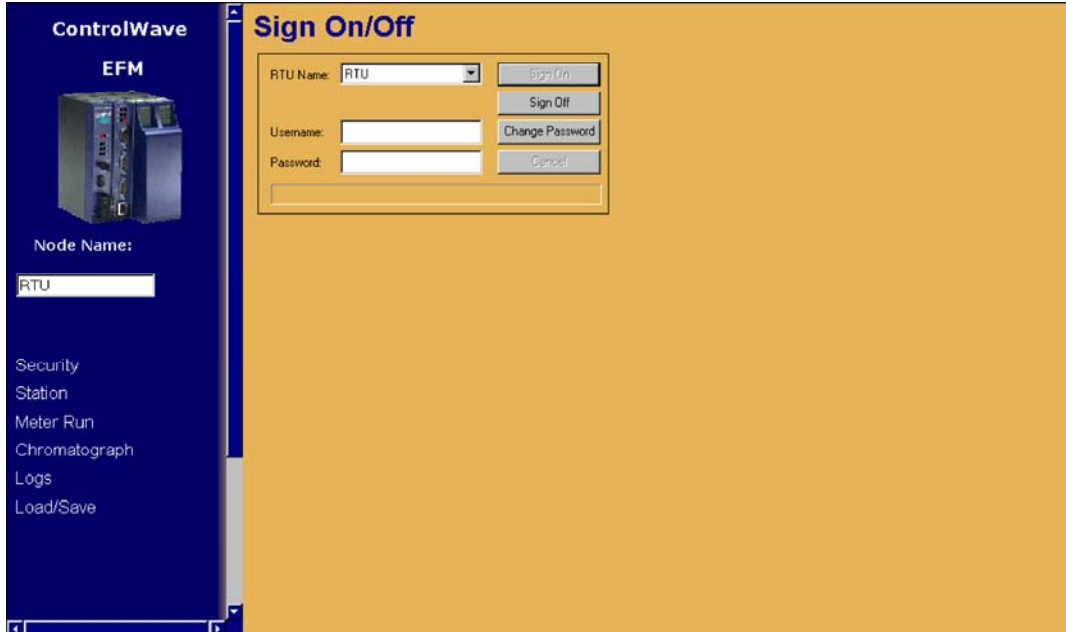
Figure F-3 - Sign On/Off Web Page

F.4.1.1 Selecting a Node and Signing On

The user must choose the Node they want to sign-on to from the RTU Name list box. The user must enter the Username and Password. The user must then click on the **Sign On** button. If the sign-on attempt is successful, the message Access Granted will appear (in green text) within the message area. Failure messages appear in red text and informational messages appear in black text.

F.4.1.2 Signing Off from the Node

To sign off from a Node, the user must click on the [Sign Off] push button. If the sign-off attempt is successful, the message "Sign Off Successful" will appear in green (failures are in red).

Note: For Security Maintenance functions refer to CW MICRO Quick Setup Guide – D5124 – Part 2 – Configuring User Accounts & Privileges.

F.4.2 Locating Nodes

The user may identify which node(s) they would like to communicate with by using the Locator page. The Nodes can be identified either by loading a proxy file, or by loading Open BSI information. In either case, they will be displayed as icons in a tree on the left side of the page.

The **Node Locator** Web page is accessible by clicking on the **Security** category button and choosing the Locate Nodes drop-down menu selection.
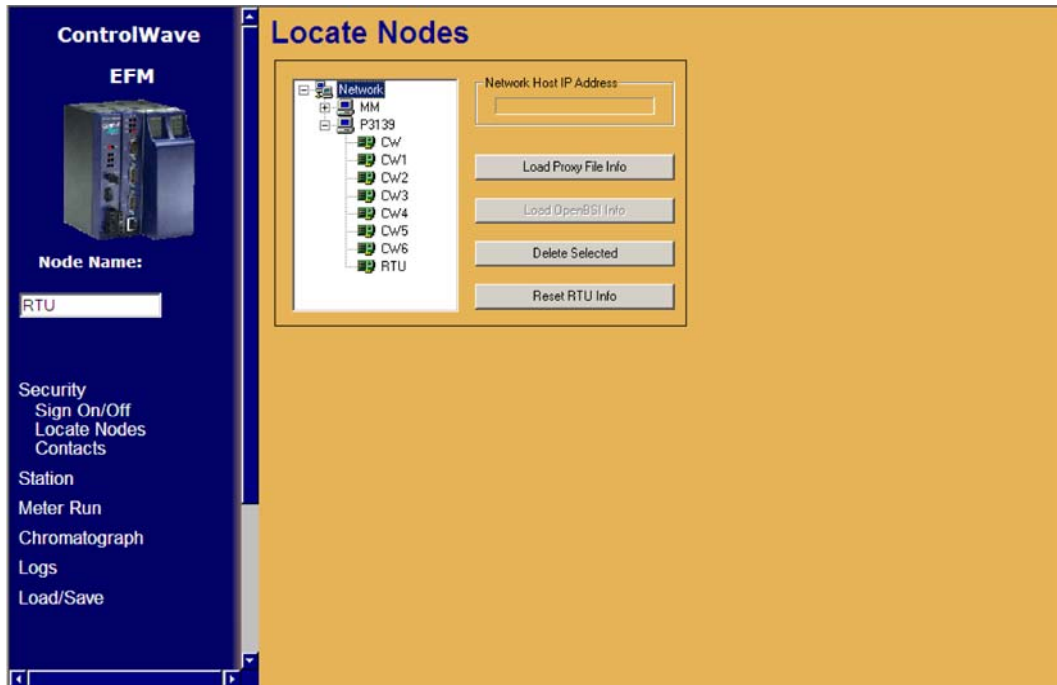
Figure F-4 - Locate Nodes Web Page

F.4.3 Contacts

A list of Bristol Inc. offices is provided under the topic Contacts.

The Contacts Page is accessible by clicking on the **Security** category button and choosing the Contacts drop-down menu selection.

F.5 STATION CATEGORY FUNCTIONS

The standard application program for the **Control**Wave **EFM** allows the user to configure a station with up to four meter runs. Users must configure Station parameters from the **Station Configuration** category section of WebBSI. Seven Web Pages are accessible from the **Station Configuration** category section of WebBSI.

- Station Summary   (Section F.5.1)
- Sampler & Odorizer   (Section F.5.2)
- Mechanical Counter   (Section F.5.3)
- Nominations   (Section F.5.4)
- Flow Control   (Section F.5.5)
- Run Switching   (Section F.5.6)
- Radio Control   (Section F.5.7)

F.5.1 Station Summary

Station Summary Web Pages display corrected and uncorrected flow rates and volumes for the station and each run. Corrected Volumes, Uncorrected Volumes and Accumulated Energy totals are displayed for the previous hour and previous day.

Figure F-5 - Station Summary Web Page

F.5.2 Sampler and Odorizer Configuration

See section F.5.2.1 for Sampler Configuration or F.5.2.2 for Odorizer Configuration.

F.5.2.1 Sampler Configuration

The user may enable or disable the Sampler by using the **Enable/Disable** button. If enabled, the Sampler will operate at a frequency set by the Pulse Frequency setpoint (in cubic feet). Users must select which Digital Output (DO) Point will be used. A running count of samples taken will be displayed. Users may reset this count by pressing the **Reset Count** button.

F.5.2.2 Odorizer Configuration

Users may enable or disable the Odorizer by using the **Enable/Disable** button. The user also selects the Output Mode, i.e., Analog Output or Digital Output. If the Analog Output Mode is selected, Analog Point ID 1 is assigned. If the Digital Output Mode is selected, the Digital Output Point to be used is selected via the DO Point ID field.

When the Analog Output Mode is selected, the user must set the Scale Factor. The Scale Factor is a ratio of the amount of odorant to be injected per cubic foot of gas. Users must know the maximum output of the Odorizer and calculate the ratio accordingly.

When the Digital Output Mode is used, the user must enter the frequency of the pulses per volume through the meter (in cubic feet).

Figure F-6 - Sampler & Odorizer Configuration Web Page

F.5.3 Mechanical Counter Configuration

The **Mechanical Counter Configuration** section of the **Sampler & Mechanical Counter Configuration** Web Page is used to simulate a mechanical counter. An **Enable/Disable** button is used to activate/deactivate this function. Synchronization of the **Control**Wave **EFM** Counter with an external Mechanical Counter is achieved via the Initial Count field. Determination of the volume of gas per pulse is performed utilizing the Pulse Frequency field. Current Count is the actual number of pulses received by the unit. Users must select which HSC Input will be used with the Mechanical Counter.

Figure F-7 - Mechanical Counter Configuration Web Page

Nomination

MICRO EFM Time	01/29/1987 03:51:40		
Main Function	Disabled	Stop Mode	Valve Control
Quantity Units	Volume	Daily Only Mode	Disabled
Control Mode	Valve Control	Alarm at a Level of (%)	100.0000
Status	Stopped	Alarm Status	CLEAR

------------------Current Nomination Period - In Progress------------------					
Start day/hour:	0	0	Stop day/hour:	0	0
Target value (x1000)	0.0000		Amount Delivered (x1000)	0.0000	
% elapsed time	0.0000		% Delivered	0.0000	

-----Next Nomination Period - Enter Before Current Stop time is Reached ----					
Start day/hour:	0	7	Stop day/hour:	0	7
Target Value (x1000)	0.0000	FT3/HOUR			

-----Last Nomination Period - Stored Data from Previous Nomination-----					
Start day/hour:	0	0	Stop day/hour:	0	0
Target Value (x1000)	0.0000				
Amount Delivered	0.0000		Percent Delivered	0.0000	

Figure F-8 - Nomination Web Page

F.5.4 Nomination

Users configure the nominations control from the **Nomination** WebPage. Nominations functionally provide the user with the ability to set the **Control**Wave **EFM** to allocate precise amounts of gas flow during specific time periods. These periods are called "*nomination periods*." A nomination may be set for any duration of time (not to exceed one month). The volume to be delivered (nominated) during a nomination period is the *target*. Targets may be specified in terms of volume or energy. Users set a nomination period by keying in the desired day of the month and hour to begin the period and the desired day of the month and hour to end the period. The *daily nomination* feature is used if the user desires the same start/stop times every day. A unit programmed with a daily nomination, will ignore the programmed start and end day numbers and will perform the nomination in question at the same time once per day.

The delivery of the nominated quantity (volume or energy during the nomination period) may be performed via one of the two unique schemes listed below.

Valve Control
The *Valve Control* method overrides PID flow control and allows the valve to be independently controlled, thus permitting full flow of gas through the meter in order to

arrive at the target (volume or energy) as quickly as possible without regard to the programmed end time.

Flow Control

The *Flow Control* method internally enables the PID flow control algorithm in order to hit the target volume/energy at exactly the programmed end time.

The user programs the **Control**Wave **EFM** t(via the 'Stop Mode' button) to either close the valve upon reaching the target or leave it in its last position.

F.5.4.1 Nomination Operation

See sections F.5.4.1.1 through F.5.4.1.5.

F.5.4.1.1 Enabling the Nomination Function

The nomination function runs once per calculation cycle after the volume and energy accumulations have been updated by the **Control**Wave **EFM**. To setup and enable this feature follow the steps below.

1. Setup of the nominations feature depends on the desired control mode selection, i.e., the *Fast approach* mode or *PID* mode. Fast approach mode is the default mode for nominations. If the desired control mode is the Fast approach mode, proceed to step 2; however, if the desired control mode selection is the PID mode, you must first program all the PID tuning parameters such as gain and integral. **Note: DON'T** enable the PID flow control algorithm or the **Control**Wave **EFM** will automatically disable nomination. When properly configured the **Control**Wave **EFM** will automatically enable the PID flow control algorithm during nomination periods.

2. Select the Nomination Web Page (Figure F-8) via the Nomination button under the **Station** Category Function (see Figure F-5 or F-9).

   A description of the menu entries (Figure F-8) used to implement the nomination function follows:

   <u>NOMINATION CONTROL</u> – In addition to the Time, this section of the Nomination Web Page provides the following eight areas for nomination setup/selection:

   Main function
   The *Main function* selection is used to enable/disable the nomination function. If this signal is set to the disable state, nomination will not occur.

   Quantity units
   The *Quantity units* selection is used to set the target units as MCF or MMBTU.

   Control mode
   Control mode provides for the selection of either the <u>Valve Control</u> or <u>Flow Control</u> modes of nomination operation.

   Status
   The Status signal is an output of the nominations algorithm that indicates whether there is currently a nominations period in progress. The user may change the state of

this signal to end an in progress nomination immediately, or to start the next period immediately (see Manually Starting/Ending a Nomination Period).

Stop Mode
The *Stop mode* selection allows the user to automatically have the valve closed, i.e., shut-in on stop mode, or left in the last position upon reaching the target (or programmed end period).

Daily Only Mode
When Daily mode is enabled, only the programmed start and end hours are used by the **Control**Wave **EFM**; the Start/Stop days are ignored, i.e., nomination begins and ends within a 24 hour period every day.

Alarm at a level of %
The *Alarm at a level of %* setting can be configured as percentage of Volume (MCF) or Energy (MMBTU). This feature allows the **Control**Wave **EFM** to provide an alarm (logical nomination alarm) or indication to an operator or computer that a specified amount of target has been reached. The number entered (1 to 100) sets the percentage at which the logical nomination alarm will occur. The status of this setting, i.e., whether or not a nomination alarm has occurred, can be determined via the Alarm Status signal (see Figure F-9).

Alarm Status
When the amount specified in 'Alarm at a Level of (%)' is reached, the value of the signal will be set true.

CURRENT NOMINATION PERIOD - This section allows the operator to view the following information associated with a nomination which is currently in progress:

Start: day/hour
The actual time and day of the month when the current nomination period started is displayed. This may be the programmed time or the time at which an operator manually started a period.

Stop: day/hour
The programmed end time and day of the month at which the current nomination period will end. If using the Fast approach mode, the period may end sooner, i.e., when the target is reached. If using the daily nomination feature, the stop date (day) will show 0 to indicate that only the hour matters.

Target value (x 1000)
The Target value provides the value of Volume/Energy to be delivered during this period.

Amount Delivered (x 1000)
The Amount Delivered reading provides the actual amount of volume/energy delivered so far during this period.

Percent elapsed time
This signal shows the percentage of time which has elapsed for the current nomination period, e.g., 4 hours into a 100 hour nomination period would cause this value to be 4.0.

Percent Delivered

This signal provides the percentage of target delivered to this point in the current nomination period.

NEXT NOMINATION PERIOD - This section allows the operator to set/view the following parameters associated with the next nomination which is to be programmed (has been programmed): *Note: New entries must be made prior to the ending of the current nomination period.*

Start: day/hour

The actual start day of the month (1-31) and start hour (0-23) when the next nomination period is to start is displayed or entered. The start day is ignored if the daily nomination feature is enabled.

Stop: day/hour

The actual stop day of the month (1-31) and stop hour (1-23) when the next nomination period is to end is displayed or entered. The stop day is ignored if the daily nomination feature is enabled.

Target Value (x 1000)

The Target value provides (is used to set) the value of Volume/Energy to be delivered during the next nomination period.

LAST NOMINATION PERIOD - This section allows the operator to view information associated with the last nomination period which was completed. Information displayed remains valid until the next time a nomination period ends (when the information is upgraded to reflect the new "last" nomination period. Start and end times stored here indicate the actual time that the nomination period ended, which is not necessarily the programmed time (because of the time required to close/open valves or complete other actions). The days are valid even if the daily nomination mode is active.

3. Program all the configuration items for the **NEXT Nomination Period** such as start and stop times and target value.

4. Set the desired parameters for **NOMINATION CONTROL** such as *Quantity units*, *Control mode*, *Stop mode*, *Daily only mode* and *Alarm at a level of* and then set the *Main function* signal to the Enable State.

5. If a radio is to be used in conjunction with a "logical nomination alarm," access the Radio Control Configuration Web Page (see Figure F-12) via the Radio Control button. See Section F.5.6 to configure the radio for logical nomination alarms.

F.5.4.1.2 Beginning a Nomination Period

When no nomination period is in progress, the **Control**Wave **EFM** compares the <u>NEXT</u> start date and time to the current time. If the date and time match (or time only for the daily nomination mode), a new period is begun. The current time is copied into the <u>CURRENT START</u> signals, and the next target is copied into the current target. The accumulators for the current period are zeroed and the current stop time is set to the next start time. If the PID mode is selected, a new flow setpoint is calculated and stored in the setpoint signal. The PID setpoint is recalculated every 15 minutes and whenever any parameter is changed.

F.5.4.1.3 Ending a Nomination Period

If <u>shut-in on stop</u> mode is in use, the current period will end when the target accumulation is reached. At this time, the **Control**Wave **EFM** attempts to close the control valve. If PID control is being used, the setpoint is set to 0.0, the current cycle will ramp down accordingly. When the flow rate reaches 0.0, the current cycle accumulations and the actual end time are copied into the <u>LAST</u> signals. If the valve fails to close, the volume will continue to accumulate until the programmed end time. If the shut-in on stop mode is not in use, the nomination period continues until the programmed end time.

F.5.4.1.4 Changing the Nomination Target

To change the target of the next period, the user should change the <u>NEXT TARGET</u> signal.

F.5.4.1.5 Manually Starting/Ending a Nomination Period

When a Nomination Period is not in progress, the user can immediately begin the <u>NEXT</u> period by setting the Status signal to the ON state. The current start time will reflect the time that the user started the cycle. The target and stop times used will be those of the <u>NEXT</u> period. The user may immediately end a nomination period which is in progress by setting the Status signal to the OFF state. The current time will be stored as the <u>LAST</u> stop time.

F.5.5 Flow Control & Valve Control

The Flow Control & Valve Control Web Page (Figure F-9) is accessible via the **Flow Control** button. The PID Controller is utilized in the **Control**Wave **EFM** for Flow Rate Control. Sections F.5.5.1 through F.5.5.4 provide information on the four major functions accessible from the Flow Control & Valve Control Web Page (see Figure F-9).

F.5.5.1 Nomination

Function
The <u>Nominations Function</u> provides for enabling/disabling the nominations feature (see Section F.5.3). If this signal is set to the disable state, no nomination will be performed.
Status
The <u>Status</u> signal is an output of the nominations algorithm that indicates whether there is currently a nominations period in progress. The user may change the state of this signal to end an in progress nomination immediately, or to start the next period immediately (see Manually Starting/Ending a Nomination Period in Section F.5.3).

F.5.5.2 Flow Control

Enable
Pressing the button to the right of <u>Enable</u> will allow the operator to toggle between **PID Flow Control** <u>Enabled</u> and <u>Disabled</u>. It is recommended that <u>GAIN</u>, <u>INTEGRAL</u> and <u>DERIVATIVE</u> adjustments be checked before turning a controller ON.

Warning

Do not enable PID Flow Control without first checking the external process control loop. The initial values displayed on the PID Menu may drive some critical processes beyond the extremes of safe limits. This could result in fire, explosion,

***property damage, and injury to persons. When setting the WebBSI Web Page
parameters, make sure the associated process is observed and protected.***

Figure F-9 - Flow Control & Valve Control Web Page

Setpoint (x1000)
This field contains the operating point at which the flow rate is to be controlled. Set-point units are MSCFH with a default setting of 1000 MSCF per Hour. To change the Setpoint value, right click on the field and select Change Signal Value.

Gain
Gain controls the amount of output change resulting from a change of the measured variable. The default value of 1.00 is typically used as a starting point; final gain is usually less. To change the Gain value, right click on the field and select Change Signal Value.

Integral
Integral determines the time it will take the PID to correct an error in the measured variable. The number of times the output is adjusted in a given time period is specified in seconds. An entry of 60 seconds can be used as a starting point; this would provide one (1) repeat per minute. To change the Integral value, right click on the field and select Change Signal Value.

Derivative
Derivative compensates for a rapidly changing measured variable. The time is specified in seconds (SECS) and most applications will use a setting of zero (0). To change the Derivative value, right click on the field and select Change Signal Value.

Deadband
Deadband provides a means of specifying a 'window' in which the variable does not affect the output. This entry is in percent (%) of the SETPOINT signal. As an example, a 5% entry would mean that the controller output must exceed the present setpoint by 5% before the output is changed. To change the Deadband value, right click on the field and select Change Signal Value.

Max Flow Rate (x1000)
Max Flow Rate represents the maximum flow rate allowed. If the number entered in the Setpoint field exceeds the Max Flow Rate value, the Max Flow Rate value will be used. To change the Max Flow Rate (x1000) value, right click on the field and select Change Signal Value.

Valve Travel Time
Valve Travel Time is the amount of time it takes a Control Valve to go from being fully open to fully closed (or visa-versa). The default value is 30 Seconds. To change the Valve Travel Time value, right click on the field and select Change Signal Value.

Current Data Flow Rate (x1000)
The Flow Rate value is Read Only data; it is the present calculated flow rate per hour.

F.5.5.3 Pressure Override (set one or both to enable override)

When the PID controller is active in flow-control mode, it will adjust a pressure valve to maintain the established flow rate setpoint. Pressure override is used in situations where full line pressure should not be applied to the downstream equipment or in circumstances where a minimum pressure must be maintained.

Maximum & Minimum
A Maximum and Minimum pressure can be configured which set the PID controller to switch to pressure control mode whenever the line pressure attempts to go outside the defined limits. The pressure override mode becomes active when either or both limits are set to a non-zero value.

Pressure Tap Location Relative to the Control Valve
The Pressure Tap location is specified as either upstream UPSTRM or downstream DNSTRM with respect to the control valve. The action of the override controller depends on the configured Tap location. When the pressure tap is configured as Downstream of the control valve, pressure will rise as the valve opens to increase the flow rate. Increasing demand will cause the valve to open more. Should conditions occur that cause the pressure to exceed the maximum pressure limit, the override will take control and close the valve to maintain the configured maximum pressure. Should the valve attempt to close and reduce pressure below the configured maximum pressure, the override will take control to maintain the minimum pressure. When the pressure tap is configured as Upstream, the action is reversed, i.e., when the maximum pressure is exceeded the valve will open to lower the pressure. When the minimum pressure is exceeded the valve will be closed.

Users are cautioned to test the regular override controller actions to verify correct valve movement for all expected conditions.

F.5.5.4 Valve Control

A user may select the Valve Control type, i.e., Analog Output or Raise/Lower control via the Digital Outputs. If the operator selects Analog Output control, Analog Output 1 will be used by default. Current Data will show the value of the Analog Output in percent (4mA = 0%, 20mA = 100%).

Users may set the valves Output Control into either Manual or Automatic (Auto). When Manual Mode has been selected, the current value of the Analog Output will be frozen. Users may change the Manual Analog Output value, by right clicking on the field and

entering a new value. When the mode is changed back to Automatic, the valve control starts from the last Manual value entered for Bumpless transfer.

If the user selects Raise Lower Mode, the DO associated with raising the valve must be selected and a separate DO must be selected for lowering the valve. When the Raise Lower Mode is being used, the Current Data section will display if the Raise DO is Off` or Raising and it will display the Lower DO state, i.e., Off or Lowering.

In the Manual Control mode, users may select whether to Raise or Lower the valve by using the Manual Raise or Manual Lower Output buttons. If the valve is raising and the operator pushes the Manual Lower Output button, the Raise Output will be automatically set to Off. If the valve is lowering and the **Manual Raise Output** button, is pressed, the Lower DO will automatically be set Off.

When switching back and forth between the Automatic and Manual Modes, both Raise and Lower DOs will be set to Off.

F.5.6 Run Switching

Sections F.5.6.1 and F.5.6.2 provide information on run switching properties (see Figure F-10). Enable/Disable Run Switching via a button to the right of Run Switching.

F.5.6.1 Common Properties

Current Rank shows how many runs are required to be open. Maximum Rank is selected by the user (from 2 to 4). Process Variable (PV) Selection can be Differential Pressure, Frequency or Flow Rate. The Transition Time is the amount of time required to allow run switching to access (opening or closing a run). Valve Settle Time is the amount of time allowed after the Transition Time for the process variable (PV) to settle, before allowing another run switching action to occur.

F.5.6.2 Run1/2/3/4 Properties

When a run is in Manual Mode (selected by the **Run Auto/Manual** button), the valve may be opened or closed by right clicking on the field to the right of the Current Valve Command and toggling the valve. When a run is in Auto Mode and Run Switching is enabled, the valve is controlled by the run switching logic. If the Target Rank of a run is 1, the valve will always be open. The Call Next Run Setpoint (SP) is the value if the process variable (DP, Frequency or Flow Rate) that will cause the next run to open. The process variable for calling runs is the PV from the run selected as Target Rank 1. If the run with Target Rank 1 is open, and the run with Target Rank 2 is not open when the PV for Target Rank 1 exceeds the Call Next Run SP, the Target Rank 2 will be opened. Likewise, if the PV for Target Rank 2 drops below the Call Prev Run SP, the highest ranked run that is open will be closed.

Call Next Deadband is the amount of time that the PV has to be greater than the Call Next Run SP value before the next run will be opened.

Call Previous Deadband is the amount of time that the PV has to be less then the Call Prev Run SP value before the lowest rank run will be closed.

Valve Control DO Point is the digital output point used for valve control.

Run Switching

Run Switching is	Disabled

Common Properties

Current Rank	1	Maximum Rank	4 +/-	Transition Time	30.0	Seconds
Most Recent Action	Run Added	PV Selection	Diff. Pressure	Valve Settle Time	20.0	Seconds
DP Units	String Not Found	Flow Units	SCF/HOUR			

Run 1 Properties — Run 1

Run Auto/Manual	Manual	Target Rank	1 +/-	Current Valve Command	Close	
Process Variable	-24.97	Call Next Run SP	0.00	Call Next Deadband	20.00	Seconds
		Call Prev Run SP	0.00	Call Prev Deadband	20.00	Seconds
				Valve Control DO Point	1 +/-	

Run 2 Properties — Run 2

Run Auto/Manual	Manual	Target Rank	2 +/-	Current Valve Command	Close	
Process Variable	-24.97	Call Next Run SP	0.00	Call Next Deadband	20.00	Seconds
		Call Prev Run SP	0.00	Call Prev Deadband	20.00	Seconds
				Valve Control DO Point	2 +/-	

Run 3 Properties — Run 3

Run Auto/Manual	Manual	Target Rank	3 +/-	Current Valve Command	Close	
Process Variable	-24.97	Call Next Run SP	0.00	Call Next Deadband	20.00	Seconds
		Call Prev Run SP	0.00	Call Prev Deadband	20.00	Seconds
				Valve Control DO Point	3 +/-	

Run 4 Properties — Run 4

Run Auto/Manual	Manual	Target Rank	4 +/-	Current Valve Command	Close	
Process Variable	-24.97	Call Next Run SP	0.00	Call Next Deadband	20.00	Seconds
		Call Prev Run SP	0.00	Call Prev Deadband	20.00	Seconds
				Valve Control DO Point	4 +/-	

Figure F-10 - Run Switching Web Page

F.5.7 Radio Control

The **Radio Control Configuration** Web Page is accessible for users by selecting <u>Radio Control</u>.

Radio Control Configuration						
Radio Control Mode			**No Control**			
Common Properties						
Local Address		1		**Group Number**		0
Activate Radio on Local Port Active				**Disabled**		
Radio Sensing Mode						
Start Hour		0		**End Hour**		23
Listen Interval		4000	msec	**Listen Time Out**	50	msec
Hourly Mode						
Start Time Offset Into Hour		5	Seconds	**Next On Time Hour**		0
Poll Time Per Node		26	Seconds	**Next On Time Minute**		0
Poll Time Per Group		5	Seconds	**Next On Time Second**		0
Listen Time		18	Seconds	**Turn Off Delay**	5	Seconds
Re-Calculate Next On Time		Re-Calculate				
Daily Mode						
Daily Mode Hour Offset		0				
Day Light Mode						
Day Light Mode Start Hour		0		**Day Light Mode End Hour**		0
Day Light Mode Start Minute		0		**Day Light Mode End Minute**		0

Statistics					
Current			**Previous**		
Hour Radio On Time	0	Seconds	**Hour Radio On Time**	0	Seconds
Day Radio On Time	0	Seconds	**Day Radio On Time**	0	Seconds
Month Radio On Time	0	Seconds	**Month Radio On Time**	0	Seconds

Figure F-11 - Radio Control Web Page

F.5.7.1 Radio Control Mode

Enable/Disable Radio Control via a control button to the right of Radio Control Mode.

F.5.7.2 Common Properties

Local Address
Local Address of the **Control**Wave **EFM** is set via the **RTU Configuration Parameters** Page in NETVIEW or LOCAL VIEW.

Group Number
Group Address of the **Control**Wave **EFM**. This is set via the **RTU Con-figuration Parameters** Page in NETVIEW or LOCAL VIEW.

Activate Radio on Local Port Active
When using any of the radio port scheduling modes (Radio Sensing, Hourly, Daily or Daylight) Port 2 (the Radio Port) is inactive unless communications are scheduled. However, by enabling the Activate Radio on Local Port Active mode, Port 1 (the Local Port) can be used to control the state of Port 2. By plugging a cable into Port 1, Port 2 will automatically be activated.

F.5.7.3 Radio Sensing Mode

Radio sensing allows a user to activate the radio for very short time intervals (specified in milliseconds under Listen Time Out) every so many milliseconds (specified in seconds under Listen Interval) to 'sense' a valid BSAP message on the radio's carrier frequency. If a message is not detected, the radio is deactivated. If a message is detected, the radio is left activated until it responds, after which it remains ON for another listen time interval. If no more valid messages are detected, the radio returns to 'sense' mode. This mode allows the system to use as little energy as possible to detect traffic throughout the day. Energy usage depends on the activation time and activation rate (INTERVAL). Assuming a 1 watt radio then a 200 millisecond listening period every 5 seconds is equivalent to .04 watts. Users can configure the Interval and Rate (Listening period) to suit their energy needs. Radio Sensing occurs between the START HOUR and END HOUR specified by the operator.

F.5.7.4 Hourly Mode

Start Time Offset Into Hour Seconds
Start Time Offset Into Hour Seconds specifies a user supplied offset which is used when computing the radio On Time. Start Time Offset is a factor used to calculate the On Time.

Poll Time Per Node Seconds
Poll Time Per Node Seconds sets the duration of time (seconds) allocated for com-munications per node. Poll Time Per Node time is also used to calculate the On Time.

Poll Time Per Group Seconds
Poll Time Per Group Seconds sets the duration of time (seconds) allocated for com-munications per group. Poll Time Per Group time is also used to calculate the On Time.

Listen Time Seconds
Listen Time Seconds is the amount of time (in seconds) that the radio will be enabled for (at the scheduled time, i.e., the enabled time before it will shut off due to the lack of com-munications.

Re-Calculate Next On Time
If the user makes any changes to the items that affect the On Time, it must re-calculate the Next On Time using this button.

Next On Time Hour/Minute/Second
When the Radio Control Mode is selected for Hourly, Daily or Daylight, these values represent the next time that the radio will be turned on.

Turn Off Delay Seconds
Turn Off Delay Seconds is the amount of time (in seconds) that the radio will remain enabled after successful communications have been established and completed. The radio will remain active for the time period specified at the Turn Off Delay.

F.5.7.5 Daily Mode

Daily Mode Hour Offset
When the Daily Mode is selected, the radio will be turned on once during the day. The Daily Mode Hour Offset determines which hour (0 - 23) that the radio will be turned on. On Time Minutes and On Time Seconds are calculated.

F.5.7.6 Day Light Mode

A user may want to conserve battery autonomy by using the radios only during day light hours. This is accomplished by selecting Daylight as the Radio Control Mode. Users select the start of day light using the Day Light Mode Start Hour and Day Light Mode Start Minute fields. Users select the end of day light using the Day Light Mode End Hour and Day Light Mode End Minute field.

F.5.7.7 Statistic

Current/Previous Hour Radio On Time
Current/Previous Day Radio On Time
Current/Previous Month Radio On Time

F.6 METER RUN CATEGORY FUNCTIONS

Up to six WebBSI Web Pages are accessible under the **Meter Run Category** Section of WebBSI; these include:

- Overview   (Section F.6.1)
- I/O Configuration   (Section F.6.2)
- Frequency Equation   (Section F.6.3)
- Compressibility Setup   (Section F.6.4)

The Web Page of Figure F.13 will appear when either the 'Overview' or 'Flow Equation' one category has been selected, if a **Meter Run Type** (Differential or Linear) has not been configured.

F.6.1 Meter Run Overview

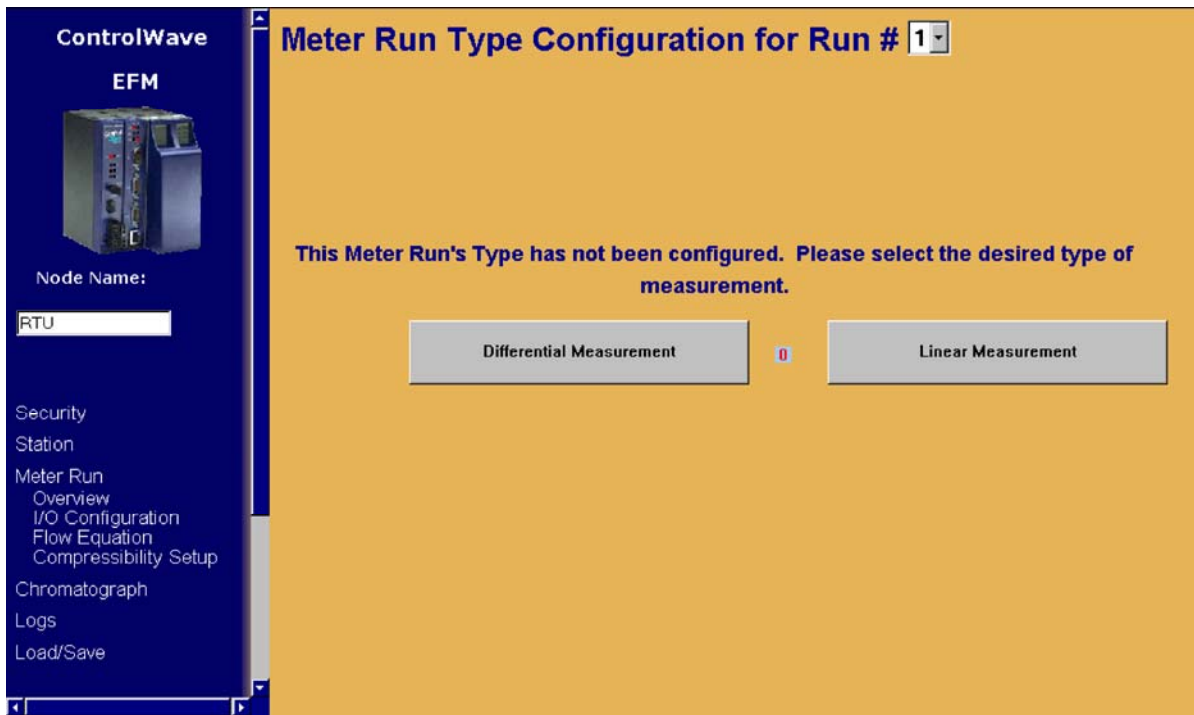See section F.6.1.1 for AGA3 Orifice Meters or F.6.1.2 for AGA7 Frequency Meters.

Figure F-12 - Meter Run Type Configuration WebPage

F.6.1.1 AGA3 - Orifice Meter

If the meter is configured as an Orifice Meter the following Read Only items are displayed:

Pipe Diameter & Orifice Diameter – To change these items, select <u>Flow Equation</u> from the left side menu section.
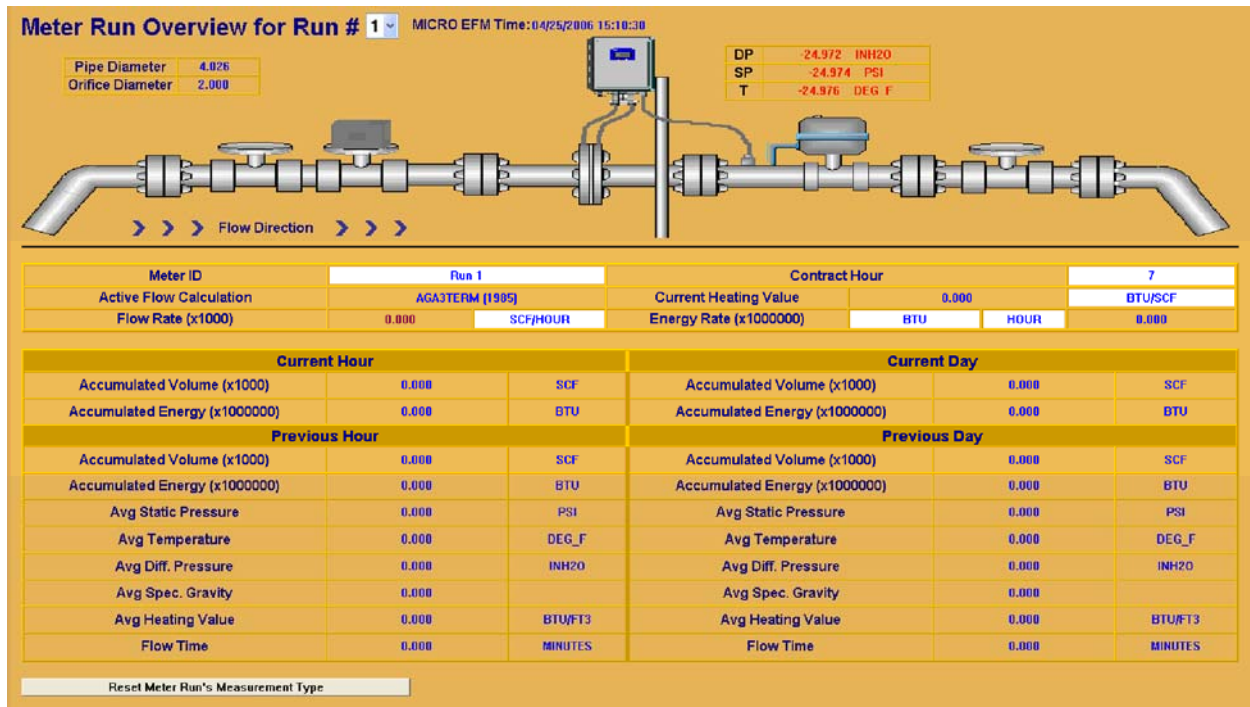

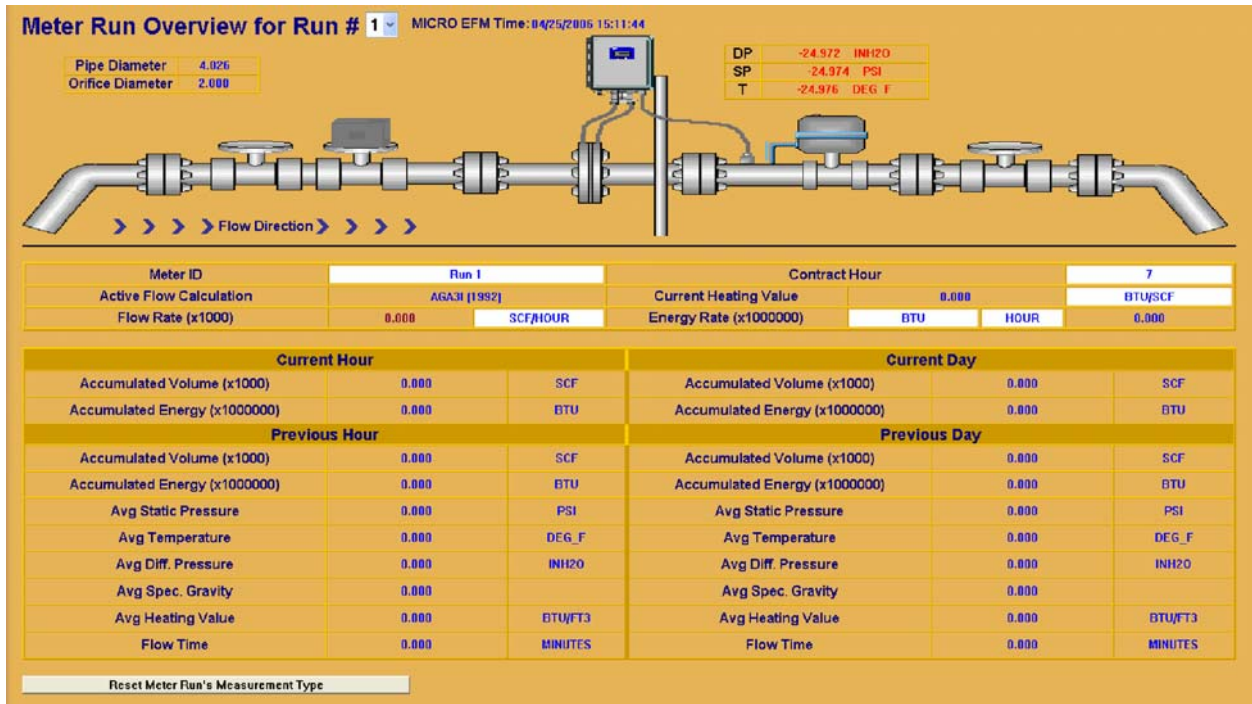**Figure F-13A - Meter Run Overview (1985 AGA3 – Orifice Meter) Web Page**

Figure F-13B - Meter Run Overview (1992 AGA3 – Orifice Meter) Web Page

DP (Differential Pressure), SP (Static Pressure) and T (Temperature) – Live Values from the Transmitters being used for calculation (selected via the I/O Configuration Page).

Active Flow Calculation – (AGA3I (1992) or AGA3 (1985) – To change an item, select Flow Equation from the left side menu section.

Current Heating Value – The instantaneous value is provided.

Flow Rate (x1000) – The instantaneous value is provided.

Accumulated Volume and Accumulated Energy 'Read Only' fields are provided for the Current Hour and Current Day:

Accumulated Volume, Accumulated Energy, Avg. Static Pressure, Avg. Temperature, Avg. Diff. Pressure, Avg. Specific Gravity, Avg. Heating Value and Flow Time 'Read Only' fields are provided for the Previous Hour and Previous Day:

The following five fields accommodate user changes:

Meter ID – a string signal identifying the meter run (default is 'Run n,') (n = the Run #).

Contract Hour – The user enters the Contract Hour for the start of the current day here.
Current Heating Value (Units) – The user may select the Heating Value units from a drop down menu; default units are BTU/Ft^3.

Flow Rate (Units) – The user may select the Flow Rate units from a drop down menu; default units are Ft^3/Hour.

Energy Rate (x1000000) – The user may select the Energy Rate - Energy Units from a drop down menu; default units are BTU. The user may select the Energy Rate - Rate Units from a drop down menu; default units are HOUR.

Reset Meter Run's Measurement Type – This button (bottom of menu) allows the user to reset the meter run's measurement type (if a mistatke hass occurred during configuration).

F.6.1.2 AGA7 Frequency Meter

If the meter is configured as a Linear Meter, following Read Only items are displayed:

Active Flow Calculation – Always AGA7
Corrected Flow Rate – Instantaneous Value
Uncorrected Flow Rate – Instantaneous Value
Current Heating Value – Instantaneous Value
Energy Value – Instantaneous Value

The following information is displayed for the Current Hour and Current Day:

Corrected Volume
Uncorrected Volume
Accumulated Energy

The following information is displayed for the Previous Hour and Previous Day:

Corrected Volume
Uncorrected Volume
Accumulated Energy
Average Static Pressure
Average Temperature
Average Specific Gravity
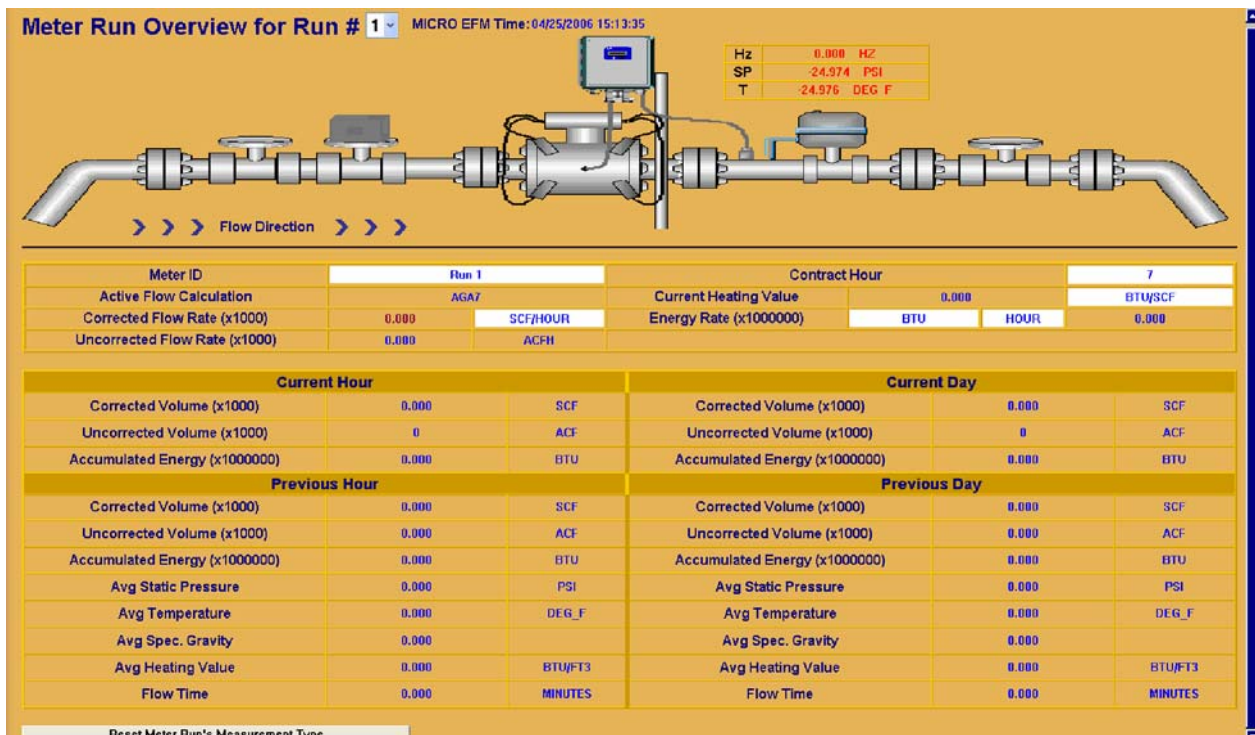**Average Heating Value**
Flow Time

Figure F-14 - Meter Run Overview (AGA7 - Frequency Meter) Web Page

There are five fields that allow the user to make changes:

Contract Hour – Users enter the Contract Hour for the start of the Contract Day here.

Current Heating Value (Units) – The user may select the Heating Value units from a drop down menu; default units are BTU/Ft^3.

Flow Rate (Units) – The user may select the Flow Rate units from a drop down menu; default units are Ft^3/Hour.

Energy Rate (x1000000) – The user may select the Energy Rate - <u>Energy Units</u> from a drop down menu; default units are BTU. The user may select the Energy Rate - <u>Rate Units</u> from a drop down menu; default units are HOUR.

Reset Meter Run's Measurement Type - This button (bottom of menu) allows the user to reset the meter run's measurement type (if a mistake has occurred during configuration).

F.6.2 Meter Run I/O Configuration

Retrieving Configuration Please Wait will initially be posted on the WebBSI Web Page when **I/O Configuration** has been selected followed by the Meter Run I/O Configuration Web Page (see Figure F-15).

The **Meter Run I/O Configuration** Web Page provides the mechanism for assigning the source for the inputs to the meter run calculations. From this page, the user would assign specific transmitters and meters to a meter run. The user may select from analog transmitters connected to I/O points, or from Smart Transmitters using BSAP or MODBUS connected via an RS-485 serial port. In addition, the user would select the source of the heating value, whether it is from a chromatograph and analog inputs or manually entered.

F.6.2.1 Differential Pressure, Static Pressure and Temperature Inputs

To select the source for pressure, differential pressure, and temperature, the user selects 'Source,' 'Point ID' and either the 'BSAP Address,' or 'MODBUS Address.'

Analog Input is used when a transmitter is connected to the **Control**Wave **GFC** via a 4-20mA or 1-5Vdc signal. The user must then select the <u>Point ID </u>on the I/O board to which the transmitter is physically connected. In addition, the zero and span settings and the engineering units must be assigned by clicking the 'Zeros & Spans' link.

Wet End is used when the internal transmitter is used. No other configuration is required.

'BSAP' is selected when an external Bristol Babcock Smart Transmitter (either the TeleTrans or the MVT) is used via RS-485 communications. The only configuration required is to assign the BSAP address (1-127) of the BBI Smart Transmitter connected to the RS-485 port.

'MODBUS' is selected when an external Smart Transmitter is used via RS-485 communications. The MODBUS interface supports the register list of the Rosemount 3095 smart multivariable transmitter. No additional configuration is required. **Note: This functionality is only available when the Expansion Communications Module is used.**

If a Zeros & Spans Button is pressed an Analog Input Configuration Web Pge Menu will appear (see Figure F16A). Zero, Span and Units can be configured for analog inputs 1 through 3. The Analog Input Configuration Web Page also allows the user to enable/disable the Damping function.

Figure F-15 - Meter Run I/O Configuration Web Page

F.6.2.2 Frequency Input

The frequency input must be brought into one of the two high-speed counter (HSC) inputs on the I/O board. Users select the two I/O points to which the typical turbine, PD, or ultrasonic meter is connected. However; if using an Invensys Auto-Adjust Turbo-Meter, both HSC inputs are used to select the Auto-Adjust Algorithm. To select the Auto-Adjust Algorithm, the user will toggle the push button under Source fromr High Speed Counter to Auto Adjust Module. In this case, the user selects which point will be used for the Main Rotor and which point will be used for the Sense Rotor.

Further configuration of the Auto-Adjust Turbine Meter is performed via the Auto-Adjust Configuration Page. (For a description of the items on the Auto-Adjust Configuration Page, see the ACCOL3 Function Block Help Documentation).

If the user selects the Auto-Adjust Configuration button the Auto-Adjust Configuration for Run # Web Page will appear (see Figure F-16B). This page provides Calibration Data, Configuration Data and Calculated Factors.

Analog Input/Output Configuration

Return to I/O Configuration   Return to Flow Control   Return to Sampler & Odorizer

Input	Live Value	Zero	Span	Units
1	-24.972	0.000	100.000	INH2O
2	-24.974	0.000	100.000	PSI
3	-24.976	0.000	100.000	DEG_F
4	-24.968	0.000	100.000	BTU/SCF

Output	Live Value	Zero	Span	
1	0.000	0.000	100.000	

Integrated Wet End Inputs

Input	Damping	Raw Value	Value In Use	Units
Differential Pressure	Enabled	-0.083	0.000	
Static Pressure	Enabled	-0.200	0.000	
Temperature	Enabled	74.240	74.244	DEG_F

Figure F-16A - Analog Input Configuration Web Page
(Accessed from Meter Run I/O Configuration Web Page)

F.6.2.3 Heating Value Input

The user has four options for the source of the heating value, Manual Entry, Chromatograph, AGA5 or Analog Input.

Manual Entry is selected when the heating value will be directly entered. This value may be entered via the Meter Run I/O Configuration Web Page, or may be written to a signal externally.

Chromatograph is selected when the heating value is read directly from the chromatograph via the MODBUS interface.

AGA5 is selected when the component mole % values are fed into the AGA5 equation. Source of the component mole % values is determined by settings made on the Chromatograph Setup Page.

Auto-Adjust Configuration for Run # 1

Calibration Data		
Blade-Tip Sensor Factor	BTSF	1.0000
Main Rotor Factor	KM	3279.6128
Sensor Rotor Factor	KS	5173.5527
Average Relative Adjustment	ABAR	9.9189
Configuration Data		
Abnormal delta-Abar high limit in percent	ABH	3.0000
Abnormal delta-Abar low limit in percent	ABL	-3.0000
Normal delta-Abar high limit in percent	WBH	1.0000
Normal delta-Abar low limit in percent	WBL	-1.0000
Adjusted and unadjusted flow total scaling factor	INCR	0.0000
Mechanical output factor	Kmo	0.0000
Calculated Factors		
Adjusted Volume rate in CF per second	Vai	0.0000
Average Main rotor rate in CF per second	Pmavg	0.0000
Average Sensor rotor rate in CF per second	Psavg	0.0000
Main rotor adjusted volume	Vm	0.0000
Sensor rotor adjusted volume	Vs	0.0000
Internal 60 second timer	R60	59.0000
Internal 512 second (8.53 minute) timer	R512	5459.9902
Internal count of Main rotor pulses	C25k	0.0000
Main rotor frequency in pulses per second	Pmif	0.0000
Sensor rotor frequency in pulses per second	Psif	0.0000
Delta time between function block executions	DeltaT	1.0000
Calculated Outputs		
Adjusted flow rate in CF per hour	Rate	0.0000
Unadjusted Main rotor rate in CF per second	Vmi	0.0000
Unadjusted Sensor rotor rate in CF per second	Vsi	0.0000
Calculated deviation of Abar from calibration in percent	Delta-Abar	0.0000
Adjusted volume change since the last function block execution	Delta-Va	0.0000
Total adjusted volume	TotA	0.0000
Total unadjusted volume	TotM	0.0000

Figure F-16B - Auto-Adjust Configuration for Run# Web Page
(Accessed from Meter Run I/O Configuration Web Page)

F.6.2.4 Alarm Configuration (Accessed via Meter Run I/O Configuration)

Alarm Configuration for Run # 1

Return to I/O Configuration

Alarm Configuration

	Differential Pressure	Static Pressure	Temperature	Frequency	Flow Rate
Enable / Disable	Enabled	Enabled	Enabled	Enabled	Enabled
Units	INH2O	PSI	DEG_F	HZ	CF/HOUI
Current Value	-24.972	-24.974	-24.976	0.000	0.000
HiHi Alarm Limit	285.000	850.000	127.500	4250.000	5000.000
Hi Alarm Limit	240.000	800.000	120.000	4000.000	3000.000
High Deadband	6.000	20.000	3.000	100.000	50.000
Low Deadband	6.000	20.000	3.000	100.000	50.000
Lo Alarm Limit	10.000	200.000	30.000	1000.000	5.000
LoLo Alarm Limit	0.000	150.000	22.500	750.000	0.000

**Figure F-17 - Alarm Configuration Web Page
(Accessed from Meter Run I/O Configuration Web Page)**

Enable/Disable - the alarm function on a per point basis.

Units and Current Value - are read from the I/O source.

Alarm Limit - are set via the appropriate alarm limit point.

Deadband - dead bands represent a range just below the high limits or just above the low limits in which the alarm variable remains in an alarm state, despite the fact that its value no longer exceeds the alarm limit. Should the alarm variable rapidly fluctuate above and below the alarm limit (without the use of dead band settings), the system will be flooded with alarm messages.

F.6.3 Flow Equations

When the user pushes the Flow Equation button (on the left side of the menu) the Flow Equation Setup Web Page that is appropriate for the meter type will appear. If the meter type has not been configured, the screen shown for Figure F-12 will appear. A user must then select the Meter Run Type to be used.

F.6.3.1 Orifice Flow Equation Setup

F.6.3.1.1 Differential Measurement

If the user configures the meter as a Differential Measurement type, the Flow Equation defaults to the AGA3 (1985) equation. Users may change to the AGA3

(1992) equation by toggling the push button labeled <u>Click Here to select AGA3I</u> <u>(1992)</u>.

F.6.3.1.2   1985 AGA3 Equation Configuration

The user must configure the inputs to the equation.

Pressure Tap – The user must select Pressure Tap type and location. The type is defined Flange or Tap and the location is defined as Upstream or Downstream. Pressure Tap is selected as follows:

1   DOWNSTREAM FLANGE
2   UPSTRERAM FLANGE
3   DOWNSTREAM TAPS
4   UPSTREAM TAPS

1985 AGA3 Equation Configuration for Run # 1

Click Here to Select AGA3I (1992)				
AGA3TERM (1985 Version)				
Inputs			**Outputs**	
Name	**Value**	**Units**	**Name**	**Value**
Pressure Tap	Flange/UpStrm		Flow	0.000
Low Flow Cut Off	0.2500	INH2O	Flow Units	FT3/HOUR
Orifice Diam.	2.0000	INCH	Low Flow Cut Off	CutOff
Pipe Diam.	4.0260	INCH	C Prime	0.000
Orif. Const. K	1.0000		Fb	0.000
Adjust Press.	14.73	PSI	Fr	0.000
Diff. Press.	-24.972	INH2O	Y	0.000
Static Press.	-24.974	PSI	Fpb	0.000
Temperature	-24.976	DEG_F	Ftb	0.000
Spec. Gravity	0.000		Ftf	0.000
FPV	1.000		Fg	0.000
Base Temp.	60.00	DEG_F	Extension	0.000
Base Press.	14.73	PSI		

Figure F-18A - (1985 AGA3) Orifice Flow Equation Setup Web Page

Low Flow Cut Off - When the differential pressure drops below the low flow cut off value, the flow rate will be set to zero. Default units are "inches of water."

Orifice Diameter - Orifice diameter is entered here. Default units are "inches."
Pipe Diameter - Diameter of the pipe is entered here. Default units are "inches."

Orifice Constant - **K (AGA3 1985) -** Orifice constant is entered here.

Adjust Press. - Users enter Average Barometric Pressure here.

Diff. Pressure - Actual value of Differential Pressure (Inches H_2O) are displayed here.

Static Pressure - Actual value of Static Pressure (psig) are displayed here.

Temperature - Actual value of Temperature (Deg. F) are displayed here.

Specific Gravity - Specific Gravity of the gas being measured is displayed here.

FPV - Supercompressibility Factor (FPV) is displayed here.

Base Temperature - Required or Contract Base Temperature is entered here (Deg. F).

Base Pressure - Required or Contract Base Pressure is entered here (psig).

The following outputs from the AGA3 calculation are displayed:

MSCF/H - Flow rate in thousands of standard cubic feet per hour

Low Flow Cut Off - Cutoff (if the DP drops below the low flow cut off value) or OK

C Prime - Orifice Flow Constant

Fb - Basic Orifice Factor

Fr - Reynolds Number Factor

Y - Expansion Factor

Fpb - Pressure Base Factor

Ftb - Temperature Base Factor
Ftf - Flowing Temperature Facture

Fg - Specific Gravity Factor

Extension - Square Feet of the Product of Differential Pressure and Static Pressure

F.6.3.1.3 1992 AGA3 Equation Configuration

The user must configure the inputs to the equation.

Pressure Tap - The user mat toggle between pressure tap settings **Flange/Upstrm** and **Flange/Dnstrm**.

Low Flow Cut Off - When the differential pressure drops below the low flow cut off value, the flow rate will be set to zero. Default units are **inches of water (H_2O)**.

Orifice Diameter - Orifice diameter is entered here. Default units are **inches**.

Pipe Diameter - Diameter of the pipe is entered here. Default units are **inches**.

Orifice Temp. Coefficient - Orifice coefficient of thermal expansion is entered here (Inches per Inch-degree F).

Pipe Temp. Coefficient - Pipe coefficient of thermal expansion is entered here (Inches per Inch-degree F).

Isentropic Exponent - Gas Isentropic Exponent is entered here. This should not be changed unless the Gas Isentropic Exponent is known to be other than the 1.3 value given in the 1992 American Gas Association (AGA3) Report.

1992 AGA3 Equation Configuration for Run # 1 ⌄

	Inputs			Outputs	
Name	**Value**	**Units**	**Name**	**Value**	
Pressure Tap	Flange/UpStrm		Flow	0.000	
Low Flow Cut Off	0.2500	INH2O	Flow Units	FT3/HOUR	
Orifice Diam.	2.0000	INCH	Low Flow Cut Off	CutOff	
Pipe Diam.	4.0260	INCH	C Prime	0.000	
Orifice Material	Stainless		Fn	0.000	
Pipe Material	Carbon		CD	0.000	
Isentropic Exponent	1.30		E	0.000	
Adjust Press.	14.73	PSI	Y	0.000	
Diff. Press.	-24.972	INH2O	Fpb	0.000	
Static Press.	-24.974	PSI	Ftb	0.000	
Temperature	-24.976	DEG_F	Ftf	0.000	
Spec. Gravity	0.000		Fgr	0.000	
Z Flowing	0.000		FPV	0.000	
Z Base	0.000		Fm	0.000	
Base Temp.	60.00	DEG_F	Extension	0.000	
Base Press.	14.73	PSI	Reynolds Number	0.000	
Viscosity	0.00000690	lbm/ft-sec.	BCF	0.000	

Click Here to Select AGA3TERM (1985)

AGA3I (1992 Version)

Figure F-18B - (1992 AGA3) Orifice Flow Equation Setup Web Page

Adjust Press. - Users enter Average Barometric Pressure here (psia).

Diff. Press. - Actual value in use is displayed here.

Static Pressure - Actual value in use is displayed here.

Temperature - Actual value in use is displayed here.

Spec. Gravity - Specific Gravity of the gas being measured is displayed here.

Z Flowing - Flowing compressibility Factor, Zf, generated from the AGA8 calculation referenced to upstream conditions.

Z Base - Base compressibility Factor from the AGA8 Gross calculation.

Base Temperature - Required and Contract Base Temperate is entered here (Deg. F).

Base Pressure - Required or Contract Base Pressure is entered here (psia). The following outputs from the AGA3 calculation are displayed:

MSCF/H - Flow rate in thousands of standard cubic feet per hour

Low Flow Cut Off - Cutoff (if the DP drops below the low flow cut off value) or OK

C Prime - Orifice Flow Constant

Fn - Numeric Conversion factor which includes Ev (the velocity of approach factor)

CD - Orifice Coefficient of Discharge

Y - Expansion Factor

Fpb - Pressure Base Factor

Ftb - Temperature Base Factor

Ftf - Flowing Temperature Facture

Fpv - Supercompressibility Factor

Fm - Additional Correction Factor

Extension - Square Root of the product of Diff. Pressure and Static Pressure ($\sqrt{DP \times SP}$)
Reynolds Number - Computed Pipe Reynolds Number

BCF - Base Correction (Zb/Zf)

F.6.3.2 Frequency Flow Equation Setup

If the user configures a meter as a linear meter, the AGA7 Calculation page appears (see Figure F-19).

Figure F-19 - Frequency Flow Equation Setup Web Page

Density Switch - Users may select whether a density meter or Gravitometer is used as an input to the equation.

Gravitometer Press. Switch - Users may save the default value for Pressure or Volume entered in the Gravitometer Press. Used field.

Gravitometer Temp. Switch - Users may use the default temperature value of the value entered in the Gravitometer Temp. Used field.

Specific Gravity - Specific Gravity of the gas being measured is displayed here.

FPV - Supercompressibility Factor is displayed here.

K Factor Units - Users may select whether the factor is in units of CuFt/Count or Counts/CuFt.

K Factor - Actual Gas Volume represented per count is entered here. The relationship is controlled by the K Factor Units switch. If the K Factor Units switch is set to CuFt/Count, and each pulse from the meter represents 100 cubic feet, the K Factor is entered as 100. If the K Factor Units switch is set to Counts/CuFt and each pulse from the meter represents 100 cubic feet, the K Factor is entered as 1/100 or 0.01.

Frequency Input - The frequency from the meter (Hz) is displayed here.

Frequency Input Max - If the frequency input exceeds the Frequency Input Max value, the Frequency Input Max value is used in the flow equation.

Static Pressure - Actual values in use for the calculation

Temperature - Actual values in use for the calculation

Pressure Adjustment - Average Barometric Pressure (psia)

Base Pressure - Required or Contract base pressure (psia)

Base Temperature - Required or Contract base temperature (Deg. F)

Calibration Factor - Sometimes referred to as Meter Factor, this is an adjustment factor issued by the meter manufacturer to account for known meter adjustments. The default 1, i.e., no adjustments required.

MSCF/H - Flow rate in thousands of standard cubic feet per hour.

MSCF/H (Max) - The maximum flow value allowed through the meter at the maximum frequency input.

F.6.4 Supercompressibility Setup

When the 1985 AGA3 calculation is selected, the Supercompressibility (Fpv) value is calculated using the NX-19 equations. When the 1992 AGA3 calculation is used the Flowing (Zf) and Base (Zb) compressibility factors are calculated using either the AGA8 Detail or AGA8 Gross module. The AGA8 Gross module provides either (G, C, N) or (HV, G, C) modes.

If the Base Pressure or Base Temperature differ from Standard conditions (14.73 psia, 60 ºF) and the 1992 AGA3 calculation is in use, an AGA8 Detail or AGA8 Gross module will be executed to calculate standard compressibility Zs for the defined gas composition. The calculation of Zs will be done once per minute or whenever a related gas constant changes.

Users may select which Supercompressibility equation to use on a per run basis. The user will click on the appropriate button to select the calculation equation to be used. The selected compressibility calculation will be shown.

Supercompressibility Configuration for Run # 1

Selected Compressibility Calculation			NX-19		
Click to Select >		NX-19	AGA8 Detail	AGA8 Gross	
Inputs				**Outputs**	
Name	Value	Name	Value	Outputs	Value
Gross Mode	Mode 2	CH_4	0.000	FPV	1.000
Static Pressure	-24.974	N_2	0.000	Z Base	0.000
Base Pressure	14.73	CO_2	0.000	Z Flowing	0.000
Temperature	-24.976	C_2	0.000		
Base Temp.	60.00	C_3	0.000		
BTU	0.000	IC_4	0.000		
Spec. Gravity	0.000	NC_4	0.000		
		IC_5	0.000		
		NC_5	0.000		
		NC_6	0.000		
		NC_7	0.000		
		NC_8	0.000		
		H_2O	0.00		
		H_2S	0.00		
		H_2	0.00		
		CO	0.00		
		O_2	0.00		
		NC_9	0.00		
		NC_{10}	0.00		
		He_2	0.00		
		Ar	0.00		

Figure F-20 - Supercompressibility Configuration Web Page

When using the AGA8 Gross Calculation, the user must select the Gross Mode1 or the Gross Mode2 calculation. The user may change the Base Pressure and the Base Temperature for this screen.

Flowing Static Pressure, Flowing Temperature, BTU and Specific Gravity in use are displayed on this page.

Values of the gas components used to calculate the Supercompressibility are displayed along with the FPV, Zflowing and ZBase values calculated by the Supercompressibility equation in use.

F.7 CHROMATOGRAPH CATEGORY FUNCTIONS

The standard application program is configured for communicating with a Daniel 2251 Gas Chromatograph, via a serial MODBUS interface. Users will configure the Chromatograph interface from the "Chromatograph Setup" Web Page (Figure F-21).

Chromatograph Setup for Run # 1

Component Range Setup

Communications Settings

Mode	Common Fixed Data	Port Number	Serial or IP	Modbus Address	IP Address
Disabled	Individual	4	Serial	1	0.0.0.0

Stream Assignment	On Chromatograph Failure...			
Run 1	Stream 1 should	Stream 2 should	Stream 3 should	Stream 4 should
1 +/-	Use Last Values	Use Last Values	Use Last Values	Use Last Values

Analysis Data

	Stream 1		Stream 2		Stream 3		Stream 4		Run 1
	Raw	Fixed	Raw	Fixed	Raw	Fixed	Raw	Fixed	Used
BTU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gravity	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Gas Components

	Raw	Fixed	Raw	Fixed	Raw	Fixed	Raw	Fixed	Used
CH4 (Methane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N2(Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C2(Ethane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C3(Propane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
IC4(I-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NC4(N-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
IC5(I-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NC5(N-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NC6(N-Hexane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NC7(N-Heptane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NC8(N-Octane)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Totals	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Out of Range	Normal		Normal		Normal		Normal		

Figure F-21 - Chromatograph Setup Web Page

F.7.1 Communication Settings

Mode – Enabled/Disabled - When this signal is ENABLED, a chromatograph is present, and gas component data is provided by the chromatograph interface. When this signal is DISABLED, the fixed values for the gas component data are used.

Common Fixed Data - When COMMON is selected fixed chromatograph values for all runs will come from the Stream 1 fixed values. When INDIVIDUAL is selected, fixed chromatograph values will come from the individual stream assigned to each run.

Port Number - When a chromatograph is present, this is the port number on the **Control**-Wave EFM that the chromatograph is connected to. The Default Port in the load is Port 4. **Note: This functionality requires that an Expansion Communications Module is installed.**

MODBUS Address - When a chromatograph is present, this is the MODBUS Address (1-246) of the chromatograph.

F.7.2 Stream Assignment and Setup

The Daniel 2251 can provide gas properties for up to 4 individual streams. The standard application program allows the user to assign any stream to any meter run (up to four streams and four runs). Each meter run may be assigned to the same stream, or each may be assigned to a different stream.

In the event of a chromatograph failure, the user may assign either fixed values to use for each gas component, or the last good values retrieved from the chromatograph. This mode is selectable on a per stream basis.

F.7.3 Analysis Data

The Raw values of BTU and Specific Gravity from the Chromatograph will be displayed for each stream. Fixed values for BTU and Specific Gravity may be entered for each stream.

F.7.4 Gas Components

The Raw value of each gas component from the chromatograph will be displayed for each stream. Fixed values for each gas component may be entered for each stream

F.7.5 Chromatograph Component Range Setup

Values of BTU, Specific Gravity and each gas component of each stream are compared to user configured (high and low) allowable limits. These limits are set from the Chromatograph Component Range Setup Web Page, accessible from the Chromatograph Setup Web Page. If a component is found to be outside the user defined limits, the value will be clamped at the closest configured limit.

It also checks the sum of the components; if the sum is outside the configurable limits, a Boolean signal is set indicating so. If any component or the total is out of range, either fixed or last values will be used.

Chromatograph Component Range Setup

Return to Chromatograph Setup

Component Out of Range Limits

Limit	Stream 1		Stream 2		Stream 3		Stream 4	
	Max	Min	Max	Min	Max	Min	Max	Min
C2(Ethane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
C3(Propane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
CH4(Methane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
CO2(Carbon Dioxide)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
IC4(I-Butane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
IC5(I-Pentane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
N2(Nitrogen)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
NC4(N-Butane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
NC5(N-Pentane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
NC6(N-Hexane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
NC7(N-Heptane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
NC8(N-Octane)	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
Gravity	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
BTU	3000.00	0.00	3000.00	0.00	3000.00	0.00	3000.00	0.00

Component Total Sum Limit

	Max	Min
Pecentage Limits (Common to all Streams)	100.00	0.00

C6+ Factors

Component	Stream 1	Stream 2	Stream 3	Stream 4
	Factor (%)	Factor (%)	Factor (%)	Factor (%)
NC6(N-Hexane)	100.00000000	100.00000000	100.00000000	100.00000000
NC7(N-Heptane)	0.00000000	0.00000000	0.00000000	0.00000000
NC8(N-Octane)	0.00000000	0.00000000	0.00000000	0.00000000

Figure F-22 - Chromatograph Component Range Setup Web Page

F.8 LOGS CATEGORY FUNCTIONS

Two WebBSI Web Pages are accessible under the Logs Category Section of WebBSI; these are:

- View Archives   (Section F.8.1)
- View Audit Trail   (Section F.8.2)
- View Signal List   (Section F.8.3)
- Archive File Collection (Section F.8.4)

F.8.1 Meter Run Archive Files

When <u>View Archive</u> has been selected, the **Meter Run Archive Files** WebBSI Web Page will be displayed (see Figure F-23). **Meter Run Archive Files** Web Pages provide three types of archive files, i.e., <u>Hourly</u>, <u>Daily</u> & <u>15 Minute</u> for each of the four runs.

Figure F-23 - Meter Run Archive File Web Page (Hourly Archive Shown)

Meter Run Archive File Web page pushbuttons allow the user to <u>Collect Data</u>, <u>Save Parameters</u>, <u>Search Criteria</u>, select <u>Floating Point Format</u> and show <u>File Definition</u>. Users can select one of the following Archive Collection Parameters: <u>File Number To Collect</u>, <u>Select from</u> <u>oldest record</u> or <u>Freeze Date/Time</u>. Users can select the archive file, (<u>Hourly</u>, <u>Daily</u> or <u>15 Minutes</u>) for the run in question by entering a number from 1 to 12 in the field adjacent to <u>File Number:</u>

Meter Run	Run ID	Hourly Archive Number	Daily Archive Number	15 Minute Archive Number
1	Run 1	1	2	3
2	Run 2	4	5	6
3	Run 3	7	8	9
4	Run 4	10	11	12

The Web page opens by default configured to view Archive 1 (<u>R1_HOURLY</u>). To view another archive, the user will enter the desired archive number in the <u>File Number:</u> field and then press the **Collect Data** button.

To save the collected archive data, the user would press the **Save Parameters** button. A <u>Save Parameters</u> dialog box will appear which will allow the user to select the file name to save the data as, and select the folder to save the data in. After selecting the file <u>Name</u> and <u>Path</u> (each box) and checking <u>Save Archive Data</u>, the file will be saved by clicking <u>OK</u> on the <u>Save Parameters</u> Dialog. The file saved is a binary file. To view the file, the user may use the Data File Conversion Utility or the UOI Dump Utility (UOIDMP.exe).

By clicking on the <u>Floating Point Format</u> button, the user may change the way Analog Values are displayed. By clicking on the <u>File Definition</u> button, the user can view how the archive file is configured.

Additionally, the **Meter Run Archive** Web page provides the number of <u>Fields Collected</u> and <u>Records Collected</u> under the <u>Stats field</u>.

F.8.2 Meter Run Audit Trail

The **Control**Wave **EFM** keeps an Audit Trail Buffer capable of storing the most recent 500 Alarms and the most recent 500 Events. Internally, these buffers are maintained separately to prevent recurring alarms from overwriting configuration audit data. Externally, they are reported to the user as a single entity. Both operate in a circular fashion with new entries overwriting the oldest entry when the buffer is full.

When <u>View Audit Trail</u> is selected, the **Meter Run Audit Trail** Web Page (see Figure F.24) will be displayed. **Meter Run Audit Trail** Web page buttons allow the user to <u>Collect Data</u>, <u>Save Parameters</u>, <u>Search Criteria</u>, and <u>Show Statistics</u>. Additionally, the **Meter Run Audit Trial** Web page posts the <u>Total # of Records Collected</u> near the top right side of the page. When the page is initially opened, only the 24 most recent records are gathered. To view more records, the user may scroll down using the Vertical Scroll Bars.

Figure F-24 - Meter Run Audit Trail Web Page (Both Alarms & Events Selected)

F.8.3 View Signal List

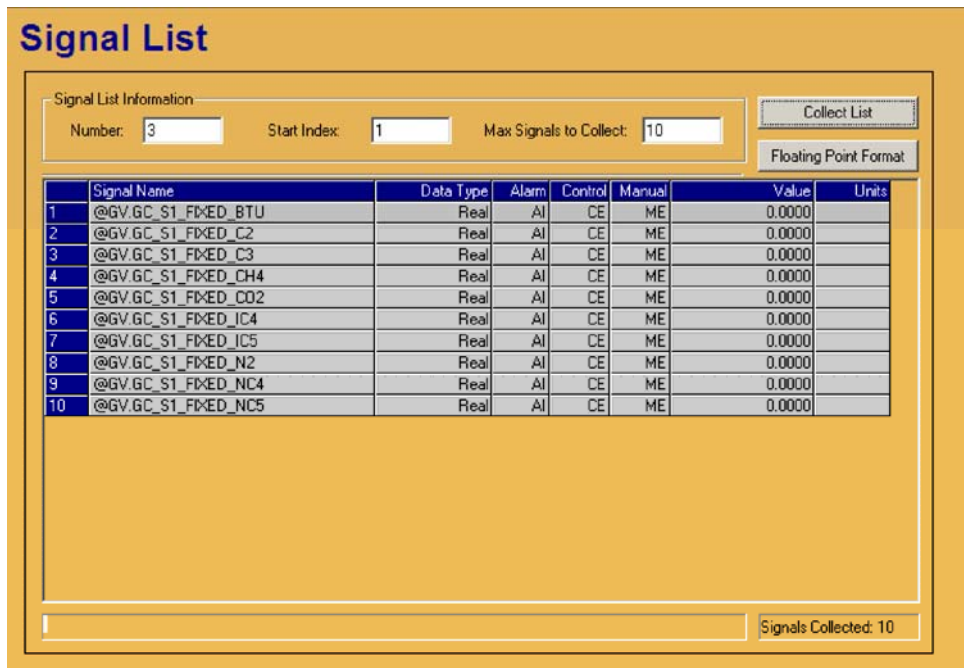|	
Signal List Information:	Number - List Number to be viewed
	Start Index - List Element to start collecting
	Max Signals to Collect – Number of Signals to collect
Collect List:	Starts list collection
Floating Point Format:	Select this button to change the appearance of Floating Point Values

Figure F-25 - Signal List Web Page

F.8.4 Archive File Collection

When Collection is selected, an Archive File Collection Web Page (see Figure F.26) will be displayed. Log Break Configuration buttons are provided on the Archive File Collection Web Page to enable/disable log breaks for configuration changes and Gas Chromatograph operation and configuration. Log Breaks are 'Disabled' by default.
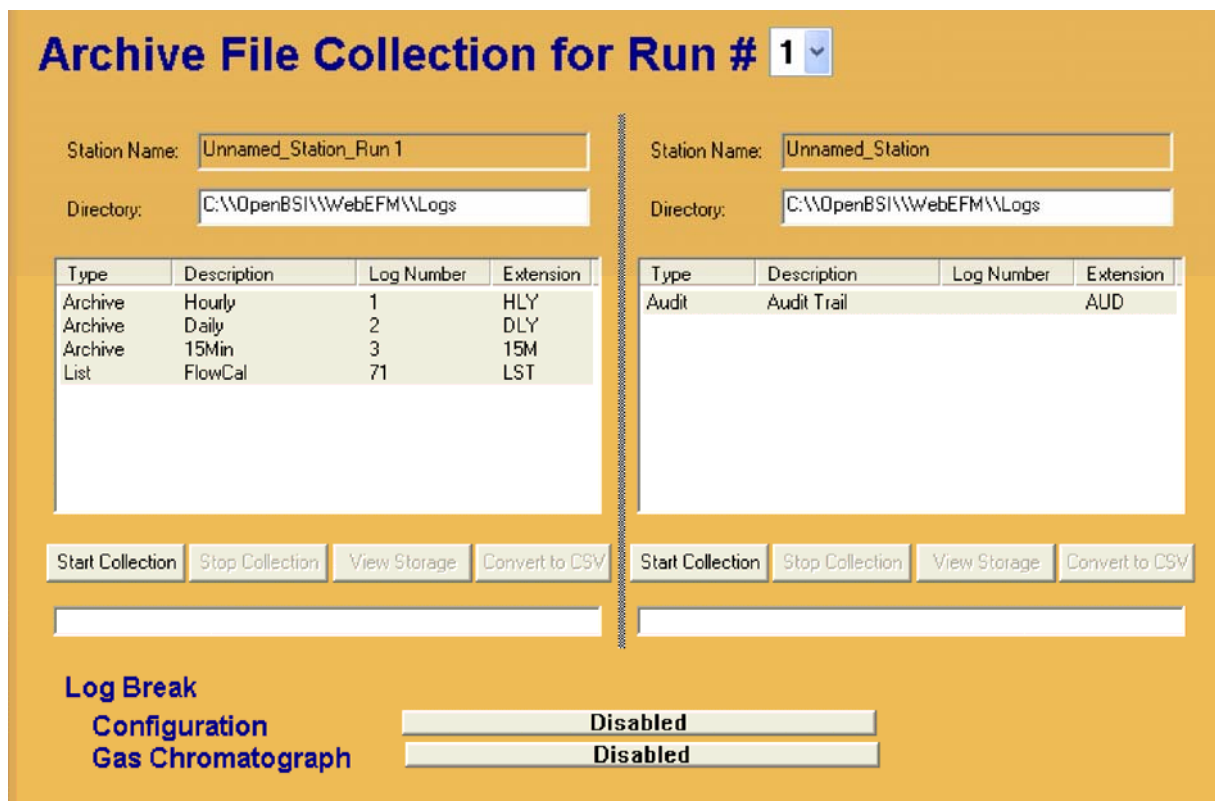

Figure F-26 - Archive File Collection Web Page

F.9 LOAD/SAVE CATEGORY FUNCTION

One WebBSI Web page is accessible under the Load/Save Category Section of WebBSI; this is called the Meter Run Save/Load Configuration Web page (see Figure F.27).

This page allows a user to save configuration parameters from a **Control**Wave **EFM** or load a saved configuration down to a **Control**Wave **EFM**. The page opens from defaults and the information displayed is retrieved from the following file:

(C:\OpenBSI\WebEFM\Config\DefaultMEFM.RCP).

The information displayed is returned from this file. If a user has made changes to the configuration of the unit, upgrade of the values can be changed by clicking on Load from RTU. The values in the configuration now reflect the actual configuration of the unit.

Figure F-27 - Meter Run Save/Load Configuration Web Page

Users may save their configuration to a file. First the user should select the file where the configuration should be save. This is done by clicking on Browse, and selecting an existing file, or by typing in a new file name to save the configuration. After the file has been selected, the date is saved by clicking on Write to File.

A user may download a previously saved configuration to the **Control**Wave **EFM**. Users would select the file to download to the unit by clicking on the <u>Browse</u> button to locate it. A user would then click on <u>Load from File</u>. This will update the recipe with the information from the file. To load the configuration to the **Control**Wave **EFM**, the user would click on <u>Write to RTU</u>. By defaults the RCP files are stored in the following folder:

(C:\OpenBSI\WebEFM\Config).

The RCP file can be edited with a text editor such as WordPad. Users may save a configuration from one meter, use a text editor to change the configuration parameters for a different meter and read the configuration from the file, and download the modified configuration to a new meter.

Users may modify the value of a signal from the **Meter Run Save/Load Configuration** page. A user would highlight the signal that needs to be modified and then click on the **Modify Signal** button. A dialog box will open with the <u>Signal Name</u> and <u>Value</u>. Users may either enter the new value for <u>String Signals</u> and <u>Analog Signals</u> or select the new value from the drop down menu (for logical signals). To write the change down to the **Control**Wave **EFM**, the user must click on <u>Write to RTU</u>. To ensure a saved configuration, the user must click on <u>Write to File</u>.

Typical Steps:

1. Open Page – Values from DefaultMEFM,RCP are shown. If there is another configuration that the user would like to use, skip to Step 7.

2. Update Values with actual settings by clicking on Load from RTU.

3. Review settings and make modifications as required using the **Modify Signal** button.

4. Click on <u>Write to RTU</u>.

5. Select the file to save the configuration to by clicking on <u>Browse</u>. Find an existing file to update or enter the name of a new file to create.

6. Click on <u>Write to File</u>. - FINISHED

7. Select another file to use by clicking on <u>Browse</u> and the desired .RCP file.

8. Click on <u>Load from File</u>. - Return to Step 2.

F.10 SPECIAL FUNCTIONS

A special Sync Date & Time web page (see Figure F-28) is accessible from the Special Functions Category Section of WebBSI.
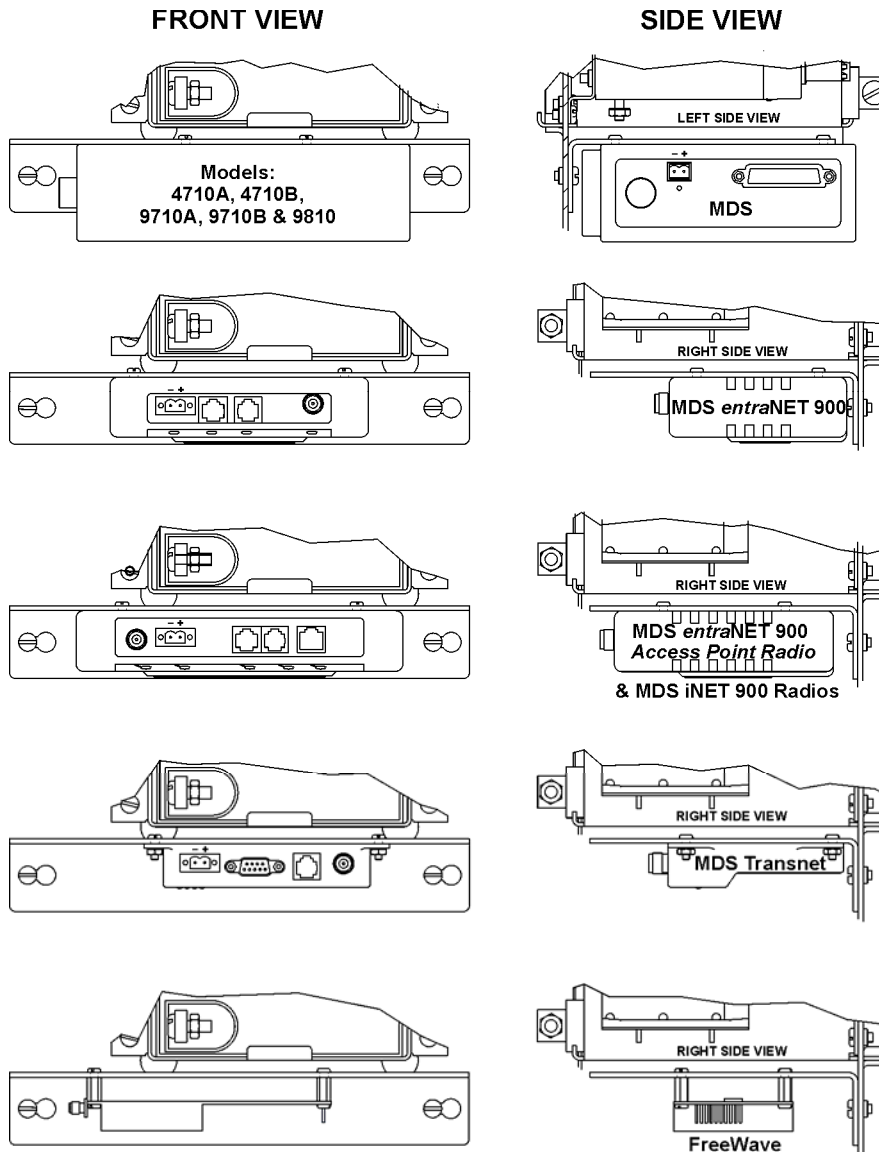
Figure F-28 - Sync Date & Time Web Page Display

ControlWave EFM RADIO READY INSTALLATION GUIDE (P/N 721700-01-2)

Appendix G

FRONT VIEW

SIDE VIEW

Models:
4710A, 4710B,
9710A, 9710B & 9810

LEFT SIDE VIEW

MDS

RIGHT SIDE VIEW

MDS *entra*NET 900

RIGHT SIDE VIEW

MDS *entra*NET 900
Access Point Radio

& MDS iNET 900 Radios

RIGHT SIDE VIEW

MDS Transnet

RIGHT SIDE VIEW

FreeWave

APPENDIX G

ControlWave EFM

Radio Ready Installation Guide

TABLE OF CONTENTS

Appendix G
RADIO READY INSTALLATION GUIDE

G1.1 GENERAL INTRODUCTION

ControlWave **EFM** Electronic Flow Meters may be ordered "Radio Equipped," or "Radio Ready." Radio Ready units contain all hardware required to field install a Bristol provided radio except the radio and radio installation hardware (such as screws, nuts and washers. Radio Ready units will include either an Internal RF Radio Cable with Bulk Head Antenna Connector or an Internal RF Radio Cable that mates to an optional Polyphaser (Surge/Impulse Suppresser).

Radios are shipped with all necessary installation hardware and are to be secured to the factory installed Radio Mounting Bracket which in turn mounts to the **Control**Wave **EFM** Fabrication Panel.

ControlWave **EFM** Electronic Flow Meters may be equipped with one of the external radios listed below or may be shipped with the hardware necessary to install one of these radios at a future date. The term "external radio," refers to those radios that mount on a Radio Mounting Bracket instead of piggy-back on an Expansion Comm. Module.

MDS 4710A – Remote Data Transceiver (Radio)
MDS 4710B – Data Transceiver (Radio)
MDS 9710A Remote Data Transceiver (Radio)
MDS 9710B Data Transceiver (Radio)
MDS 9810 – Spread Spectrum Data Transceiver (Radio)
MDS entraNET 900 Extended Range IP Networking Transceivers
MDS *i*NET 900 Ethernet Radio
MDS Transnet 900 - Spread Spectrum Data Transceiver
FreeWave Radio - Spread Spectrum Data Transceiver Model FGRM-501X005

Radios are shipped with the following additional hardware:

MDS 4710A/B, MDS 9710A/B & MDS 9810 models are provided with four (4) 6-32 x 5/16 Pan Head Screws and a Power Connector.

MDS entraNET 900 Serial Remote and Ethernet Remote models are provided with four (4) 6-32 x 5/16 Pan Head Screws and a Power Connector.

MDS entraNET 900 Access Point and MDS iNET 900 (Remote Serial Gateway, Remote Ethernet Bridge or Access Point/Remote Dual Gateway) models are provided with four (4) 6-32 x 5/16 Pan Head Screws and a Power Connector.

MDS TRANSNET radios are provided with four (4) 6-32 x 7/16 Pan Head Screws, four (4) #6 Flat 5/16 O.D. Washers and four (4) 6-32 Hex Nuts and a Power Connector.

FreeWave radios are provided with eight (8) 6-32 x 5/16 Pan Head Screws and four (4) 6-32 x .500 F/F Standoffs.

G2.1 RADIO INSTALLATION

DANGER

Radios provided by Bristol, Inc. for use in the ControlWave EFM Electronic Flow Meters are approved for use in Class I, Division 2, Groups A, B, C & D hazardous locations. Radios may also be used in non-hazardous locations. The installer must be familiar with hazardous location installation guidelines before installation or maintenance is undertaken. Do not begin radio installation or service to the ControlWave EFM unless the area is known to be non-hazardous.

NOTE

Only the external radios listed on page 1 of this document may be used in Class I, Division 2, Groups A, B, C & D hazardous locations! Use of other external radios in Class I, Division 2, Groups A, B, C & D hazardous locations is not allowed!
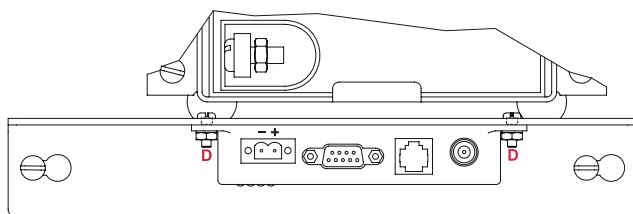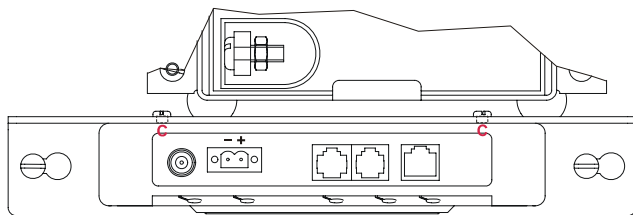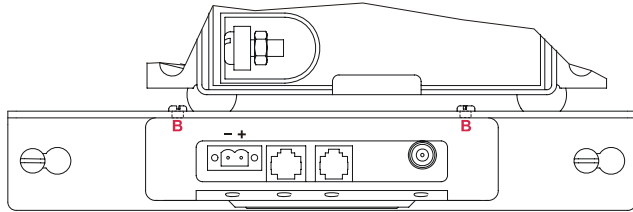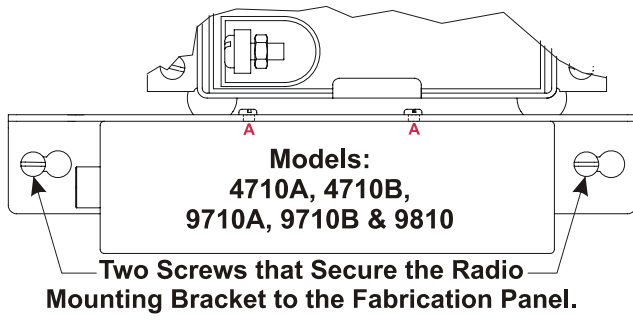
AVOID OPERATING EQUIPMENT DURING AN ELECTRICAL STORM. AN IMPULSE SUPPRESSOR MAY SAVE EQUIPMENT FROM DANGER, BUT SHOULD NOT BE CONSIDERED AS BEING SAFE FOR PERSONNEL.

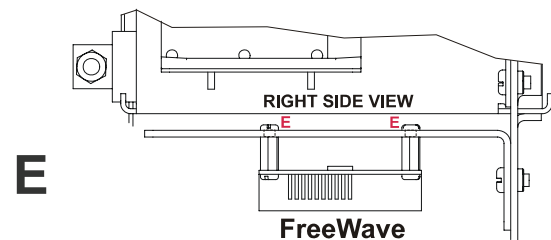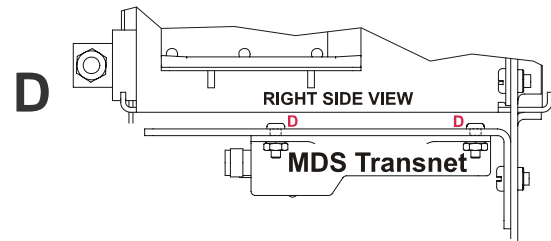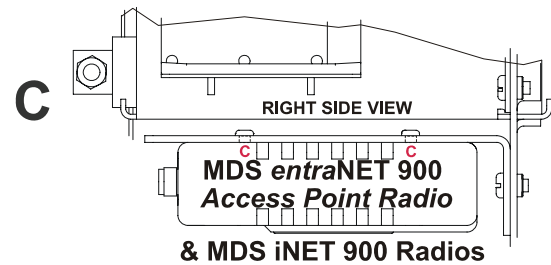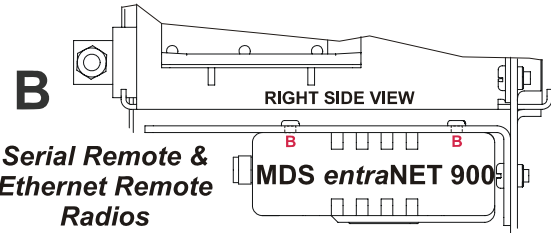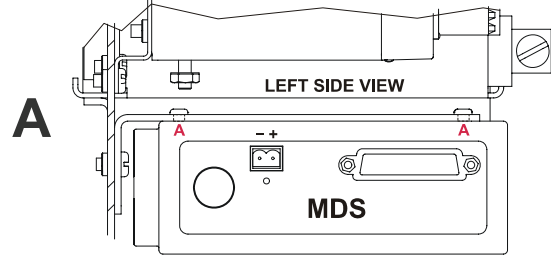### G2.1.1 Installation of a Radio into a Radio Ready ControlWave EFM

Radio Ready **ControlWave EFM** Electronic Flow Meters contain all the hard-ware required (except the radio and securing hardware) to accommodate installation and operation of the radio option.

1. Open the Instrument Front Cover.

2. Remove the Radio Mounting Bracket by removing the two 10-32 x 3/8 Pan Head Screws that secure it to the Fabrication Panel.

3. Using the mounting hardware provided with the radio, mount and secure the radio to the Radio Mounting Bracket removed in step 2 (see Figures 1 & 2).

4. Re-install the Radio Mounting Bracket to the Fabrication Panel using the two 10-32 x 3/8 Pan Head Screws that were removed in step 2.

5. Connect the radio's RF cable to the radio. The other end of the radio's internal RF cable should already be installed onto either a Polyphaser or a RF Bulk Head/Antenna Interface connector.

6. Connect the user supplied antenna cable to either the Polyphaser or Bulk Head antenna cable connector jack on the bottom of the **ControlWave EFM** (see Figure 3).

FRONT VIEW

SIDE VIEW

A

LEFT SIDE VIEW

MDS

Models:
4710A, 4710B,
9710A, 9710B & 9810

Two Screws that Secure the Radio
Mounting Bracket to the Fabrication Panel.

B

RIGHT SIDE VIEW

Serial Remote &
Ethernet Remote
Radios

MDS *entra*NET 900

C

RIGHT SIDE VIEW

MDS *entra*NET 900
Access Point Radio

& MDS iNET 900 Radios

**D**

RIGHT SIDE VIEW

MDS Transnet

E

RIGHT SIDE VIEW

FreeWave

Location of Mounting Hardware
that Secures the Radio to the
Radio Mounting Bracket.

A = MDS Models 4710A, 4710B, 9710A, 9710B & 9810
B = MDS entraNET 900 Serial Remote & Ethernet Remote
C = MDS entraNET 900 Access Point & MDS iNET 900
D = MDS TRANSNET
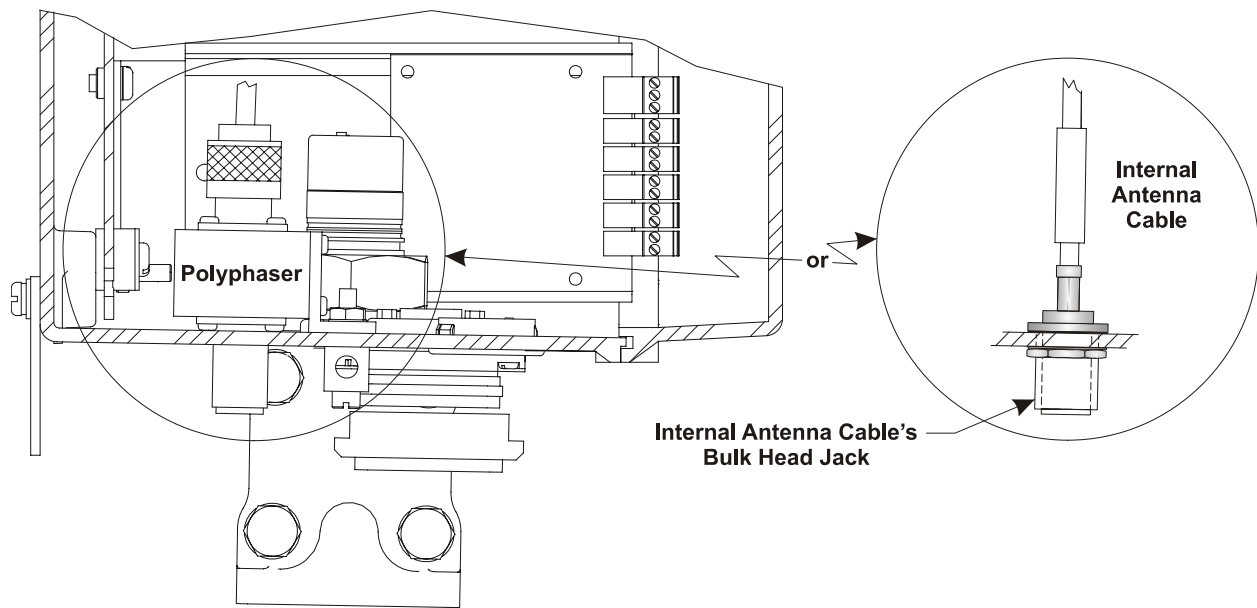E = FreeWave

Figure 1 - Radio Installation - Mounting Diagram

Fabrication Panel

TOP VIEW
Radio Mounting Bracket

FRONT VIEW
Radio Mounting Bracket
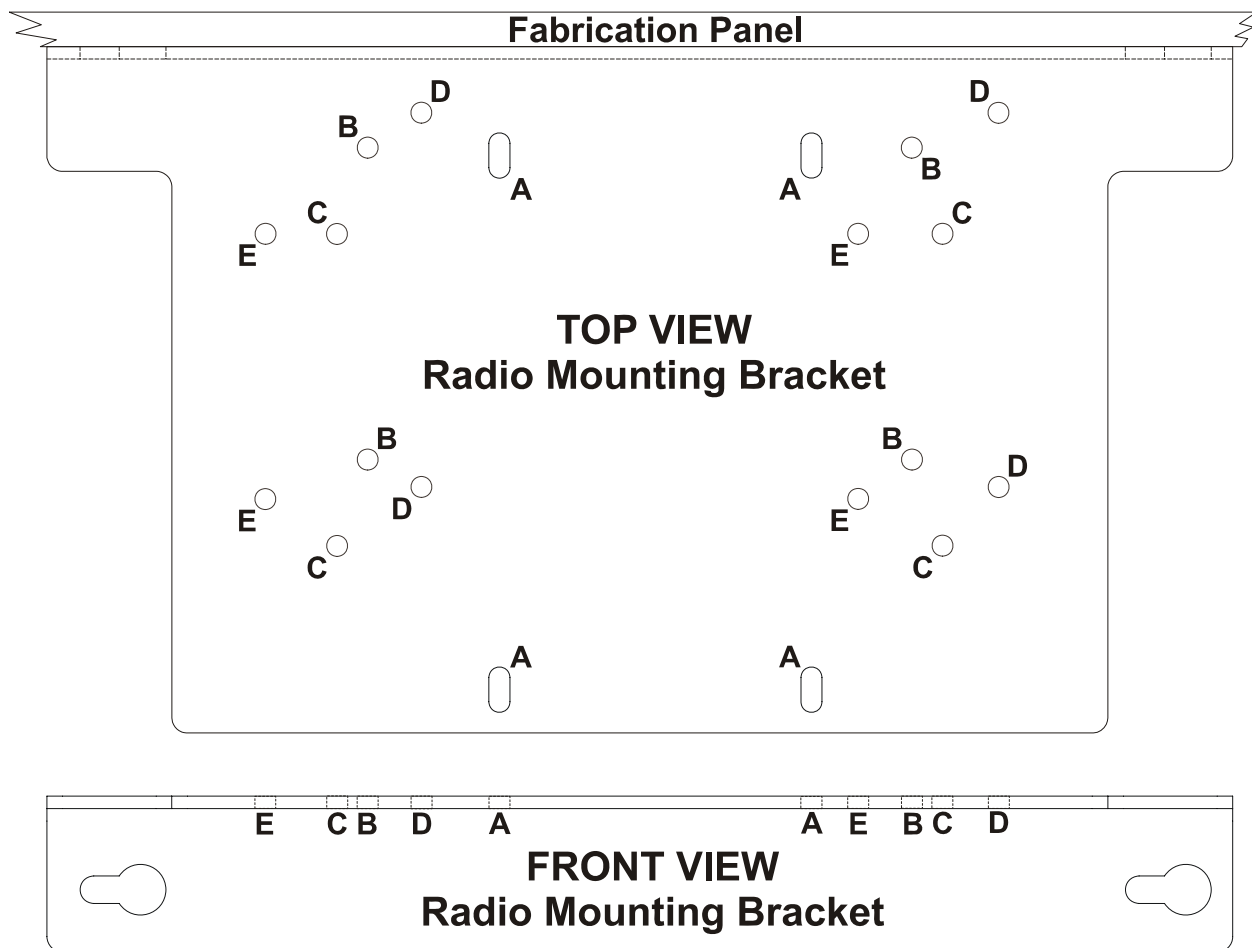
Radio Mounting Hole (A through E) Assignments

A = MDS Models 4710A, 4710B, 9710A, 9710B & 9810
B = MDS entraNET 900 Serial Remote & Ethernet Remote
C = MDS entraNET 900 Access Point & MDS iNET 900
D = MDS TRANSNET
E = FreeWave

Figure 2 - Radio Mounting Bracket - Radio Installation Diagram

7. Plug the Radio Interface Cable into the radio's Comm. Port. The other end of this cable should already be installed into Comm. Port 2. of the CPU Module. In the case of the FreeWave Radio, power is also supplied via the Interface Cable.

8. Remove the MDS Radio's Power Connector from the MDS Radio in question and connect the unterminated ends of the MDS Power Cable (shipped loose with the **Control**Wave **EFM**) to the MDS Power Connector (Red = Pos. and Black = GND) (see Figure 1). Plug the end of the MDS Radio Power Cable that you just dressed into the MDS Radio. Plug the other end of the MDS Radio Power Cable into connector TB3 of the Power Distribution Board (see Figure 4).

9. After testing the unit, close and secure the Door.

Figure 3 - Partial View - Control Wave **EFM
with/without Polyphaser Installed**

G2.2 ADDITIONAL FreeWave INFORMATION

The FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual contains in-depth details on modem parameters, operation, installation, tuning transceiver performance, and more. Copies of the FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual can be obtained from FreeWave Technologies, Inc. (electronically) by contacting their Technical Support Group.

FreeWave Tech. Support can be reached at 303-444-3862 or at www.freewave.com.

Follow the "Tuning Transceiver Performance" section of the FreeWave Technologies, Inc. FreeWave Spread Spectrum Data Transceiver Model FGRM-501X005 User Manual to configure the radio.

Note:

The setup program is invoked by connecting the radio to any PC equipped with a terminal program (such as HyperTerminal), setting the parameters for that terminal to those of Table 1, and putting the radio into setup mode.

Connection to the PC requires a special RS-232 cable with a 9-pin Female D-Type connector on the PC side and a 10-pin Female MTA-100 Connector assembly on the radio side. A cable can be constructed as illustrated in Figure 4. The terminal program must be running before invoking the setup program. The setup program is invoked by shorting MTA-100 Connector pins 4 (GND) and 2 (MENU) together.

Table 1 - Setup Menu Terminal Settings

PARAMETER	SETTING
Baud Rate	19,200
Data Rate	8
Parity	None
Stop Bits	1
Parity Check	None/Off
Carrier Detect	None/Off

Cable Side of Female D-Type Connector

Cable Side of Female MTA-100 Connector

2 = RXD
3 = TXD
5 = GND

1 = +12Vdc
4 = PWR Gnd
5 = TXD
6 = GND
7 = RXD

2 = RXD to TXD = 5
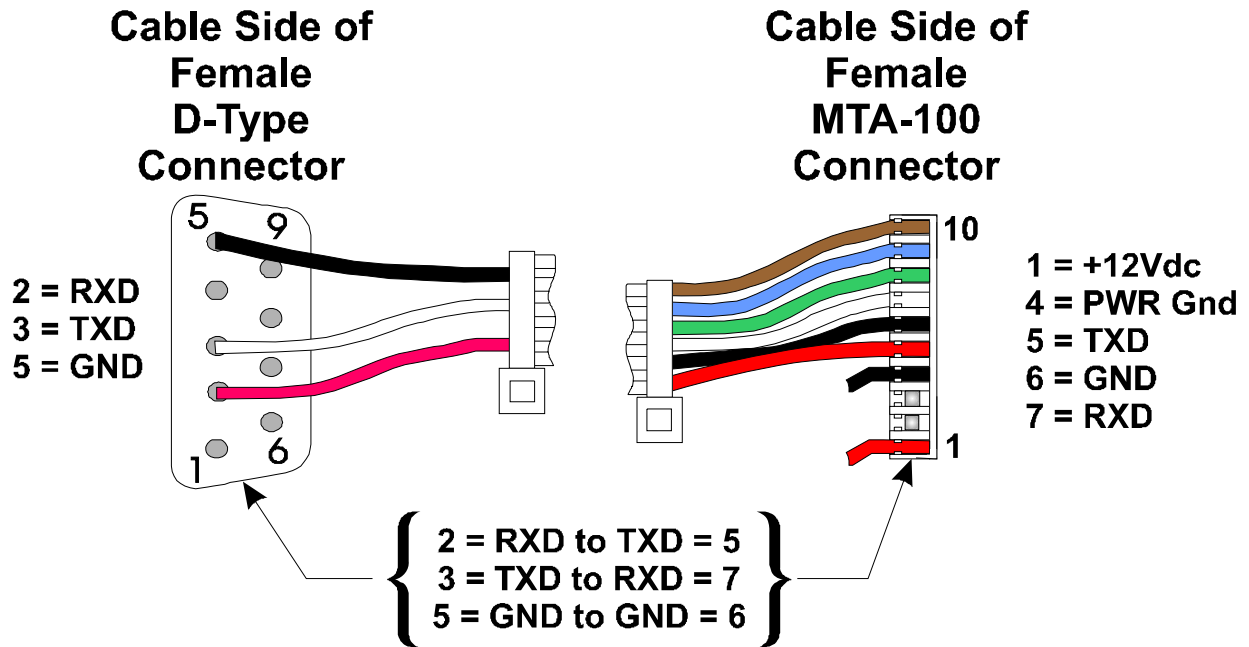3 = TXD to RXD = 7
5 = GND to GND = 6

Figure 4 - Cable Diagram for Radio to PC Interface

ControlWave EFM
Material Safety Data Sheets

A Material Safety Data Sheet is provided herein to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. This standard must be consulted for specific requirements.

Material Safety Data Sheets are provided in the order listed in Table Z-1 below.

TABLE Z-1
MSDS for ControlWave EFM Instruction Manual
(CI-ControlWave EFM

Manufacturer	General Description	Part Number
DURACELL	3V Lithium Manganese Dioxide Battery	DL 2450

Bristol Babcock Part Number = 395620-01-5

Manufacturer	General Description	Part Number
B.B. Battery Co., Ltd.	12V - 33AH/20 Hr. Sealed Lead-acid Battery	BP33-12

Bristol Babcock Part Number = 395407-03-6

Gillette
Environment
Health and Safety

37 A Street
Needham, MA 02492
Tel 781.292.8151

MATERIAL SAFETY DATA SHEET

NAME: **DURACELL LITHIUM MANGANESE DIOXIDE COIN BATTERIES**

CAS NO: Not applicable   **Effective Date:** 8/8/03   **Rev:** 3

A. — IDENTIFICATION

	%
Manganese Dioxide (1313-13-9)	65-75
Propylene Carbonate (108-32-7)	10-15
Lithium (7439-93-2)	5-10
Graphite, synthetic (7440-44-0)	5-10
1,2-Dimethoxyethane (110-71-4)	1-10
Lithium Perchlorate (7791-03-9)	<1.5

Formula: Mixture   Mixture

Molecular Weight: NA

Synonyms: Lithium Manganese Dioxide Coin Cells:
3V-DL2016; DL2025; DL2430; DL2450;
DL2032; DL1616; DL1620

B. — PHYSICAL DATA

Boiling Point		Melting Point		Freezing Point	
NA °F	NA °C	NA °F	NA °C	NA °F	NA °C

Specific Gravity (H_2O=1)	Vapor Density (air=1)	Vapor Pressure @ ___ °F
NA	NA	NA mm Hg

Evaporation (Ether =1)	Saturation in Air (by volume@ ___ °F)	Autoignition Temperature ___ °F ___ °C
NA	NA	NA

% Volatiles	Solubility in Water	pH
NA	NA	NA

Appearance/Color   Coin cells. Contents dark in color.

Flash Point and Test Method(s)   1,2-Dimethoxyethane (Approximately 3-7% of contents): 42.8 °F, 6°C (Closed Cup)

Flammable Limits in Air (% by volume)   Lower   NA %   Upper   NA %

C. — REACTIVITY

Stability   [X] stable   [ ] unstable   Polymerization   [ ] may occur   [X] will not occur

Conditions to Avoid	Conditions to Avoid
Do not heat, crush, disassemble, short circuit or recharge.	Not applicable

Incompatible Materials	Hazardous Decomposition Products
Contents incompatible with strong oxidizing agents.	Thermal degradation may produce hazardous fumes of manganese and lithium; oxides of carbon and other toxic by-products.

* IF MULTIPLE INGREDIENTS, INCLUDE CAS NUMBERS FOR EACH   NA=NOT AVAILABLE

Footnotes
Not applicable

D. — HEALTH HAZARD DATA

Occupational Exposure Limits PEL's, TLV's, etc.)

8-Hour TWAs: Manganese Dioxide (as Mn) - 5 mg/m^3 (Ceiling) (OSHA); 0.2 mg/m^3 (ACGIH/Gillette)
          1,2-Dimethoxyethane - 0.15 ppm (Gillette)
          Graphite (all kinds except fibrous) - 2 mg/m^3 (synthetic, ACGIH); 15 mg/m^3 (total, OSHA);
                  5 mg/m^3 (respirable, OSHA)

These levels are not anticipated under normal consumer use conditions.

Warning Signals

Not applicable

Routes/Effects of Exposure

These chemicals and metals are contained in a sealed can. For consumer use, adequate hazard warnings are included on both the package and on the battery. Potential for exposure should not exist unless the battery leaks, is exposed to high temperature, is accidentally swallowed or is mechanically, physically, or electrically abused.

1. Inhalation — Not anticipated. Respiratory (and eye) irritation may occur if fumes are released due to heat or an abundance of leaking batteries.

2. Ingestion — An initial x-ray should be obtained promptly to determine battery location. Batteries lodged in the esophagus should be removed immediately since leakage, burns and perforation can occur as soon as 4-6 hours after ingestion. Irritation to the internal/external mouth areas may occur following exposure to a leaking battery.

3. Skin — a. Contact
Irritation may occur following exposure to a leaking battery.

b. Absorption
Not anticipated.

4. Eye Contact — Irritation may occur following exposure to a leaking battery.

5. Other — Not applicable

E. — ENVIRONMENTAL IMPACT

1. Applicable Regulations — All ingredients listed in TSCA inventory.

2. DOT Hazard Class - — Not applicable

3. DOT Shipping Name - — Not applicable

While lithium batteries are regulated by IATA and ICAO, the type of lithium batteries offered for sale by DURACELL are considered non-hazardous per provision A45 of the IATA Dangerous Goods Regulations and provision A45 of the ICAO Technical Instructions For The Safe Transport Of Dangerous Goods By Air.   Per section A45 of the IATA and ICAO regulations, properly marked, labeled and packaged DURACELL consumer lithium batteries, which are of the solid cathode type, with less than 1g lithium per cell and less than 2g lithium per battery, are exempt from further regulation. When these batteries are separated to prevent short circuits and properly packaged in strong packaging (except when installed in electronic devices), they are acceptable for air transport as airfreight without any other restrictions. In addition, when installed in equipment or when no more than 24 cells or 12 batteries meeting the A45 provision are shipped, they are not subject to special packaging, marking, labeling or shipping documentation requirements. Thus, these batteries are not considered hazardous under the current regulations and are acceptable for air transport.

Environmental Effects

These batteries pass the U. S. EPA's Toxicity Characteristic Leaching Procedure and therefore, maybe disposed of with normal waste.

GMEL# 2033.3

F. — EXPOSURE CONTROL METHODS

Engineering Controls

General ventilation under normal use conditions.

Eye Protection

None under normal use conditions. Wear safety glasses when handling leaking batteries.

Skin Protection

None under normal use conditions. Use butyl gloves when handling leaking batteries.

Respiratory Protection

None under normal use conditions.

Other

Keep batteries away from small children.

G. — WORK PRACTICES

Handling and Storage

Store at room temperature. Avoid mechanical or electrical abuse. **DO NOT** short or install incorrectly.
Batteries may explode, pyrolize or vent if disassembled, crushed, recharged or exposed to high temperatures.
Install batteries in accordance with equipment instructions. Replace all batteries in equipment at the same
time. Do not carry batteries loose in pocket or bag.

Normal Clean Up

Not applicable

Waste Disposal Methods

No special precautions are required for small quantities. Large quantities of open batteries should be treated
as hazardous waste. Dispose of in accordance with federal, state and local regulations. Do not incinerate,
since batteries may explode at excessive temperatures.

H. — EMERGENCY PROCEDURES

Steps to be taken if material is released to the environment or spilled in the work area

Evacuate the area and allow vapors to dissipate. Increase ventilation. Avoid eye or skin contact. **DO NOT** inhale vapors. Clean-up personnel should wear appropriate protective gear. Remove spilled liquid with absorbent and contain for disposal.

Fire and Explosion Hazard	Extinguishing Media
Batteries may burst and release hazardous decomposition products when exposed to a fire situation. See Sec. C.	As for surrounding area. Dry chemical, alcohol foam, water or carbon dioxide. For incipient fires, carbon dioxide extinguishers are more effective than water.

Firefighting Procedures

Cool fire-exposed batteries and adjacent structures with water spray from a distance. Use self-contained breathing apparatus and full protective gear.

I. — FIRST AID AND MEDICAL EMERGENCY PROCEDURES

Eyes

Not anticipated. If battery is leaking and material contacts eyes, flush with copious amounts of clear, tepid water for 30 minutes. Contact physician at once.

Skin

Not anticipated. If battery is leaking, irrigate exposed skin with copious amounts of clear, tepid water for a least 15 minutes. If irritation, injury or pain persists, consult a physician.

Inhalation

Not anticipated. Respiratory (and eye) irritation may occur if fumes are released due to heat or an abundance of leaking batteries. Remove to fresh air. Contact physician if irritation persists.

Ingestion

Consult a physician. Published reports recommend removal from the esophagus be done endoscopically (under direct visualization). Batteries beyond the esophagus need not be retrieved unless there are signs of injury to the GI tract or a large diameter battery fails to pass the pylorus. If asymptomatic, follow-up x-rays are necessary only to confirm passage of larger batteries. Confirmation by stool inspection is preferable under most circumstances. If mouth area irritation/burning has occurred, rinse the mouth and surrounding area with clear, tepid water for at least 15 minutes.

Notes to Physician
1) For information on treatment, telephone (202)-625-3333 collect.
2) Potential leakage of less than 50 milligrams of propylene carbonate (CAS #108-32-1) and dimethoxyethane (CAS #110-71-4).
3) Dimethoxyethane readily evaporates.
4) Under certain misuse conditions and by abusively opening the battery, exposed lithium can react with water or moisture in the air causing potential thermal burns or fire hazard.

Replaces # 1461

The information contained in the Material Safety Data Sheet is based on data considered to be accurate, however, no warranty is expressed or implied regarding the accuracy of the data or the results to be obtained from the use thereof.

MATERIAL SAFETY DATA SHEET

SECTION 1:   PRODUCT AND MANUFACTACTURER

Product name: Sealed maintenance-free lead acid batteries

Manufacturer: B.B. Battery Co., Ltd.
Address: Chengdong Trial Area, Huanggang, Raoping, Guangdong, P.R.China 515700
Tel: +86-768-7601001 or +86-768-7601002
Fax: +86-768-7601469

US Office: B&B Battery USA, Inc.
Address: 6415 Randolph Street, Commerce, CA 90040
Tel: 323-278-1900
Fax: 323-278-1268

SECTION 2: HAZARDOUS COMPONENTS

COMPONENTS	%WEIGHT	TLV	LD50 ORAL	LC50 INHALATION	LC50 CONTACT
Lead (Pb, PbO2, $PbSO_4$)	About 70%	N/A	(500) mg/Kg	N/A	N/A
Sulfuric Acid	About 20%	1 mg/m3	(2.140) mg/Kg	N/A	N/A
Fiberglass Separator	About 5%	N/A	N/A	N/A	N/A
ABS or PP	About 5%	N/A	N/A	N/A	N/A

SECTION 3: PHYSICAL DATA

COMPONENTS	DENSITY	MELTING POINT	SOLLUBILITY (H_2O)	ODOR	APPEARANCE
Lead	11.34	327.4°C (Boiling)	None	None	Sliver-Gray Metal
Lead Sulfate	6.2	1070°C (Boiling)	40 mg/l (15°C)	None	White Powder
Lead Dioxide	9.4	290°C (Boiling)	None	None	Brown Powder
Sulfuric Acid	About 1.3	About 114°C (Boiling)	100%	Acidic	Clear Colorless Liquid
Fiberglass Sep.	N/A	N/A	Slight	Toxic	White Fibrous Glass
ABS or PP	N/A	N/A	None	No Odor	Solid

SECTION 4: PROTECTION

EXPOSURE	PROTECTION	COMMENTS
SKIN	Rubber gloves, Apron, Safety shoes	Protective equipment must be worn if battery is cracked or otherwise damaged.
RESPIRATORY	Respirator (for lead)	A respirator should be worn during reclaim operations if the TLV exceeded.
EYES	Safety goggles, Face Shield	

SECTION 5: FLAMMABILITY DATA

COMPONENTS	FLASHPOINT	EXPLOSIVE LIMITS	COMMENTS
Lead	None	None	
Sulfuric Acid	None	None	
Hydrogen	259*	4% - 74.2%	Sealed batteries can emit hydrogen only if over charged (float voltage> 2.4 VPC). The gas enters the air through the vent caps. To avoid the chance of a fire or explosion, keep sparks and other sources of ignition away from the battery. Extinguishing Media: Dry chemical, foam, CO_2
Fiberglass Sep.	N/A	N/A	Toxic vapors may be released. In case of fire: wear self-contained breathing apparatus.
478 Polystyrene	None	N/A	Temperatures over 300 °C (572°F) may release combustible gases. In case of fire: wear positive pressure self-contained breathing apparatus.

SECTION 6: REACTIVITY DATA

COMPONENT	Lead/lead compounds
STABILITY	Stable
INCOMPATIBILITY	Potassium, carbides, sulfides, peroxides, phosphorus, sulfurs.
DECOMPOSITION PRODUCTS	Oxides of lead and sulfur.
CONDITIONS TO AVOID	High temperature, Sparks and other sources of ignition.
COMPONENT	Sulfuric Acid
STABILITY	Stable at all temperatures
POLYMERIZATION	Will not polymerize
INCOMPATIBILITY	Reactive metals, strong bases, most organic compounds
DECOMPOSITION PRODUCTS	Sulfuric dioxide, trioxide, hydrogen sulfide, hydrogen
CONDITIONS TO AVOID	Prohibit smoking, sparks, etc. from battery charging area. Avoid mixing acid with other chemicals.

SECTION 7: CONTROL MEASURES

1. Store lead/acid batteries with adequate ventilation. Room ventilation is required for batteries utilized for standby power generation. Never recharge batteries in an unventilated, enclosed space.
2. Do not remove vent caps. Follow shipping and handling instructions that are applicable to the battery type. To avoid damage to terminals and seals, do not double-stack industrial batteries.
STEPS TO TAKE IN CASE OF LEAKS OR SPILLS
If sulfuric acid is spilled from a battery, neutralize the acid with sodium bicarbonate (baking soda), sodium carbon (soda ash), or calcium oxide (lime).
Flush the area with water discard to the sewage systems. Do not allow unneutralized acid into the sewage system.
WASTE DISPOSAL METHOD:
Neutralized acid may be flushed down the sewer. Spent batteries must be treated as hazardous waste and disposed of according to local state, and federal regulations. A copy of this material safety data must be supplied to any scrap dealer or secondary smelter with battery.
ELECTRICAL SAFETY
Due to the battery's low internal resistance and high power density. High levels of short circuit can be developed across the battery terminals. Do not rest tools or cables on the battery. Use insulated tools only.
Follow all installation instruction and diagrams when installing or maintaining battery systems.

SECTION 8: HEALTH HAZARD DATA

LEAD: The toxic effects of lead are accumulative and slow to appear. It affects the kidneys, reproductive, and central nervous system.

The symptoms of lead overexposure are anemia, vomiting, headache, stomach pain (lead colic), dizziness, loss of appetite, and muscle and joint pain. Exposure to lead from a battery most often occurs during lead reclaim operations through the breathing or ingestion of lead dusts and fumes.

THIS DATA MUST BE PASSED TO ANY SCRAP OR SMELTER WHEN A BATTERY IS RESOLD.

SULFURIC ACID: Sulfuric acid is a strong corrosive. Contact with acid can cause severe burns on the skin and in the eyes. Ingestion of sulfuric acid will cause GI tract burns. Acid can be release if the battery case is damaged or if the vents are tampered with.

FIBERGLASS SEPARATOR: Fibrous glass is an irritant of the upper respiratory tract, skin and eyes. For exposure up to 10F/CC use MSA Comfort with type H filter. Above 10F/CC up to 50F/CC use Ultra-Twin with type H filter.

NTP or OSHA does not consider this product carcinogenic.

SECTION 9: SULFURIC ACID PRECAUTIONS

INHALATION: Acid mist form formation process may cause respiratory irritation, remove from exposure and apply oxygen if breathing is difficult.

SKIN CONTACT: Acid may cause irritation, burns or ulceration. Flush with plenty of soap and water, remove contaminated clothing, and see physician if contact area is large or if blisters form.

EYE CONTACT: Acid may cause severe irritation, burns, cornea damage and blindness. Call physician immediately and flush with water until physician arrives.

INGESTION: Acid may cause irritation of mouth, throat, esophagus and stomach. Call physician. If patient is conscious, flush mouth with water, have the patient drink milk or sodium bicarbonate solution.

DO NOT GIVE ANYTHING TO AN UNCONSCIOUS PERSON.

SECTION 10: TRANSPORTATION REGULATIONS

We hereby certify that all B.B. Battery Maintenance Free Rechargeable Sealed Lead Acid batteries conform to the UN2800 classification as " Batteries, wet, Non- Spillable, and electric storage" as a result of passing the Vibration and Pressure Differential Test described in DOT [49 CFR 173.159(d) and IATA/ICAO [Special Provision A67].

B.B. Batteries having met the related conditions are EXEMPT from hazardous goods regulations for the purpose of transportation by DOT, and IATA/ICAO, and therefore are unrestricted for transportation by any means. For all modes of transportation, each battery outer package is labeled "NON-SPILLABLE".

Supplement Guide - S1400CW

ControlWave™

SITE CONSIDERATIONS
For
EQUIPMENT INSTALLATION,
GROUNDING
&
WIRING

A Guide for the Protection of
Site Equipment & Personnel
In the Installation of
ControlWave
Process Automation Controllers

Bristol Babcock

Supplement Guide S1400CW
SITE CONSIDERATIONS FOR EQUIPMENT INSTALLATION, GROUNDING & WIRING

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Supplement Guide S1400CW
SITE CONSIDERATIONS FOR EQUIPMENT INSTALLATION, GROUNDING & WIRING

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REFERENCE DOCUMENTS

1. IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems - ANSI/IEEE Std 142-1982
2. IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise inputs to Controllers from External Sources - IEE Std 518-1982
3. Lightning Strike Protect; Roy B. Carpenter, Jr. & Mark N. Drabkin, Ph.D.; Lightning Eliminators & Consultant, Inc., 6687 Arapahoe Road, Boulder Colorado
4. Lightning Protection Manual for Rural Electric Systems, NRECA Research Project 82-5, Washington DC, 1983
5. Grounding for the Control of EMI; Hugh W. Denny; Don White Consultants, Inc., 1983, 1st Edition
6. Fundamentals of EGM - Electrical Installations; Michael D. Price; NorAm Gas Transmission, 525 Milam Street, Shreveport, Louisiana 71151
7. TeleFlow Modem Grounding Kit 621495-01-8 Installation Instructions - PIP-3530MGKI; Bristol Babcock, Watertown, CT 06795

Section 1 - Overview

1.1 INTRODUCTION

This document provides information pertaining to the installation of **Control**Wave systems; more specifically, information covering reasons, theory and techniques for protecting your personnel and equipment from electrical damage. Your instrument system affects the quality of service provided by your company and many aspects of its operational safety. Loss of instruments means lost production and profits as well as increased expenses.

Information contained in this document is for educational purposes. Bristol Babcock makes no warranties or guarantees on the effectiveness or the safety of techniques described herein. Where the safety of installations and personnel is concerned, refer to the National Electrical Code Rules and rules of local regulatory agencies.

1.2 MAJOR TOPICS

Topics are covered in seven sections designed to pinpoint major areas of concern for the protection of site equipment and personnel. The following overview is provided for each of the major sections.

- **Section 2 - Protection**
  This section provides the reasons for protecting instrument systems. An overview of the definition of quality and what we are trying to accomplish in the protection of site installations and how to satisfy the defined requirements is presented. Additionally, this section provides considerations for the protection of personnel and equipment.

- **Section 3 - Grounding & Isolation**
  Information pertaining to what constitutes a good earth ground, how to test and establish such grounds, as well as when and how to connect equipment to earth grounds is provided

- **Section 4 - Lightning Arresters & Surge Protectors**
  Some interesting information dealing with Lightning strikes and strokes is presented in technical and statistical form along with a discussion of how to determine the likelihood of a lightning strike. Protecting equipment and personnel during the installation of radios and antenna is discussed in a review of the dangers to equipment and personnel when working with antennas. Reasons for the use of lightning arresters and surge protectors are presented along with overviews of how each device protects site equipment.

- **Section 5 - Wiring Techniques**
  Installation of Power and "Measurement & Control" wiring is discussed. Information on obscure problems, circulating ground and power loops, bad relays, etc. is presented. Good wire preparation and connection techniques along with problems to avoid are discussed. This sections list the ten rules of instrument wiring.

Section 2 - Protection

2.1 PROTECTING INSTRUMENT SYSTEMS

Electrical instrumentation is susceptible to damage from a variety of natural and man made phenomena. In addition to wind, rain and fire, the most common types of system and equipment damaging phenomena are lightning, power faults, communication surges & noise and other electrical interference's caused by devices such as radios, welders, switching gear, automobiles, etc. Additionally there are problems induced by geophysical electrical potential & noise plus things that are often beyond our wildest imagination.

2.1.1 Quality Is Conformance To Requirements

A quality instrumentation system is one that works reliably, safely and as purported by the equipment manufacturer (and in some cases by the system integrator) as a result of good equipment design and well defined and followed installation practices. If we except the general definition of quality to be, "quality is conformance to requirements," we must also except the premise that a condition of "quality" can't exist where requirements for such an end have not been evolved. In other words, you can't have quality unless you have requirements that have been followed. By understanding the requirements for a safe, sound and reliable instrumentation system, and by following good installation practices (as associated with the personnel and equipment in question), the operational integrity of the equipment and system will be enhanced.

Understanding what is required to properly install BBI equipment in various environments, safely, and in accordance with good grounding, isolating and equipment protection practices goes a long way toward maintaining a system which is healthy to the owner and customer alike. Properly installed equipment is easier to maintain and operate, and is more efficient and as such more profitable to our customers. Following good installation practices will minimize injury, equipment failure and the customer frustrations that accompany failing and poorly operating equipment (of even the finest design). Additionally, personnel involved in the installation of a piece of equipment add to or subtract from the reliability of a system by a degree which is commensurate with their technical prowess, i.e., their understanding of the equipment, site conditions and the requirements for a quality installation.

2.2 PROTECTING EQUIPMENT & PERSONNEL

ControlWave installations must be performed in accordance with National Electrical Code Rules, electrical rules set by local regulatory agencies, and depending on the customer environment (gas, water, etc), other national, state and local agencies such as the American Water Works Association (AWWA). Additionally, installation at various customer sites may be performed in conjunction with a "safety manager" or utility personnel with HAZMAT (hazardous material) training on materials present (or potentially present) as required by OSHA, the customer, etc.

2.2.1 Considerations For The Protection of Personnel

Always evaluate the site environment as if your life depended on it. Make sure that you understand the physical nature of the location where you will be working. Table 2-1 provides a general guideline for evaluating an installation site.

Table 2-1 - Installation Site Safety Evaluation Guide

#	Guide
1	Indoor or outdoor – Dress Appropriately
2	If outdoor, what kind of environment, terrain, etc. Watch out for local varmint (bees, spiders, snakes, etc.)
3	If indoor or outdoor – determine if there are any pieces of dangerous equipment or any processes which might be a risk to your safety
4	If in a tunnel, bunker, etc. watch out for a build up of toxic or flammable gases. Make sure the air is good. Watch out for local varmint (bees, spiders, snakes, etc.)
5	Hazardous or Non-Hazardous Environment – Wear appropriate safety equipment and perform all necessary safety measures.
6	Before installing any equipment or power or ground wiring, make sure that there are no lethal (life threatening) voltages between the site where the instrument will be installed and other equipment, pipes, cabinets, etc. or to earth itself.
7	Never assume that adjacent or peripheral equipment has been properly installed and grounded. Determine if this equipment and the **Control**Wave unit in question can be touched simultaneously without hazard to personnel and/or equipment?
8	Before embarking to remote locations where there are few or no human inhabitants ask a few simple questions like, should I bring water, food, hygienic materials, first aid kit, etc? Be Prepared!
9	Observe the work habits of those around you – for your own safety!

Some of the items that a service person should consider before ever going on site can be ascertained by simply asking questions of the appropriate individual. Obviously other safety considerations can only be established at the installation site.

2.2.2 Considerations For The Protection of Equipment

Always evaluate the site installation/service environment and equipment. Understand the various physical interfaces you will be dealing with such as equipment mounting and supporting, **Control**Wave analog and digital circuits, power circuits, communication circuits and various electrical grounds. Table 2-2 provides a general guideline for evaluating the equipment protection requirements of an installation site.

Table 2-2 - Equipment Protection Site Safety Evaluation Guide

#	Guide	Reference Section
1	Environment - Class I, Division 2 - Nonincendive Environment - Class I, Division 1 - Intrinsically Safe Other - Safe or unrated area	See Appendix A of CI Manual See Appendix B of CI Manual
2	Earth Ground - Established by mechanical/electrical or (both) or not at all.	See Section 3
3	Is the area prone to lightning strikes?	See Section 4
4	Are there surge suppressors installed or to be installed?	See Section 4
5	Are there overhead or underground power or com-munication cables in the immediate area?	See Section 2.3

Table 2-2 - Equipment Protection Site Safety Evaluation Guide (Continued)

#	Guide	Reference Section
6	Is there an antenna in the immediate area?	See Section 4.1.2
7	How close is other equipment? Can someone safely touch this equipment and a **Control**Wave simultaneously?	See Section 2.3
8	Determine equipment ground requirements. How will the **Control**Wave and its related wiring be grounded? Consider Earth Ground, Circuit Ground, Conduit Ground, Site Grounds!	See Section 3
9	Are there any obviously faulty or questionable power or ground circuits?	See Section 2.3

2.3 OTHER SITE SAFETY CONSIDERATIONS

Overhead or underground power or communication cables must be identified prior to installing a new unit. Accidentally cutting, shorting or simply just contacting power, ground, communication or process control I/O wiring can have potentially devastating effects on site equipment, the process system and or personnel.

Don't assume that it is safe to touch adjacent equipment, machinery, pipes, cabinets or even the earth itself. Adjacent equipment may not have been properly wired or grounded, may be defective or may have one or more loose system grounds. Measure between the case of a questionable piece of equipment and its earth ground for voltage. If a voltage is present, something is wrong.

AC powered equipment with a conductive case should have the case grounded. If you don't see a chassis ground wire, don't assume that it is safe to touch this equipment. If you notice that equipment has been grounded to pipes, conduit, structural steel, etc., you should be leery. *Note: AWWA's policy on grounding of electric circuits on water pipes states, "The American Water Works Association (AWWA) opposes the grounding of electrical systems to pipe systems conveying water to the customer's premises…."*

Be sure that the voltage between any two points in the instrument system is less than the stand-off voltage. Exceeding the stand-off voltage will cause damage to the instrument and will cause the instrument to fail.

Section 3 - Grounding & Isolation

3.1 POWER & GROUND SYSTEMS

ControlWaves utilize DC power systems. AC power supplies are not provided with **Control**Wave units. **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/EFC**, **Control**Wave**RED**, **Control**Wave**REDIO** and **Control**Wave I/O Expansion Racks are provided with a Ground Lug that accommodates up to a #4 AWG size wire for establishing a connection to Earth Ground. In the case of the **Control**Wave**LP**, a Chassis Ground termination terminal (TB2, Pin-3), that accepts up to a #14 AWG size wire, is provided on the unit's Power Supply/Sequencer Board.

3.2 IMPORTANCE OF GOOD GROUNDS

ControlWave units (see above) are utilized in instrument and control systems that must operate continually and within their stated accuracy over long periods of time with minimum attention. Failures resulting from an improperly grounded system can become costly in terms of lost time and disrupted processes. A properly grounded system will help prevent electrical shock hazards resulting from contact with live metal surfaces, provide additional protection of equipment from lightning strikes and power surges, minimize the effects of electrical noise and power transients, and reduce signal errors caused by ground wiring loops. Conversely, an improperly grounded system may exhibit a host of problems that appear to have no relation-ship to grounding. It is essential that the reader (service technician) have a good under-standing of this subject to prevent needless troubleshooting procedures.

WARNING

*This device must be installed in accordance with the National Electrical Code (NEC) ANSI/NEPA-70. Installation in hazardous locations must also comply with Article 500 of the code. For information on the usage of **Control**Wave units in Class I, Division 2, Groups C & D Hazardous and Nonhazardous locations, see appendix A of the applicable Customer Instruction (CI) manual. For information on the usage of **Control**Wave units in Class I, Division 1, Groups C & D Hazardous locations, see appendix B of the applicable Customer Instruction (CI) manual.*

3.3 EARTH GROUND CONNECTIONS

To properly ground a **Control**Wave unit, the units Chassis Ground (post or terminal) must ultimately be connected to a known good Earth Ground. Observe recommendations provided in topics Establishing a Good Earth Ground and Ground Wire Considerations.

3.3.1 Establishing a Good Earth Ground

A common misconception of a ground is that it consists of nothing more than a metal pipe driven into the soil. While such a ground may function for some applications, it will often

not be suitable for a complex system of sophisticated electronic equipment. Conditions such as soil type, composition and moisture will all have a bearing on ground reliability.

A basic ground consists of a 3/4-inch diameter rod with a minimum 8-foot length driven into conductive earth to a depth of about 7-feet as shown in Figure 3-1. Number 3 or 4 AWG solid copper wire should be used for the ground wire. The end of the wire should be clean, free of any coating and fastened to the rod with a clamp. This ground connection should be covered or coated to protect it from the weather and the environment.
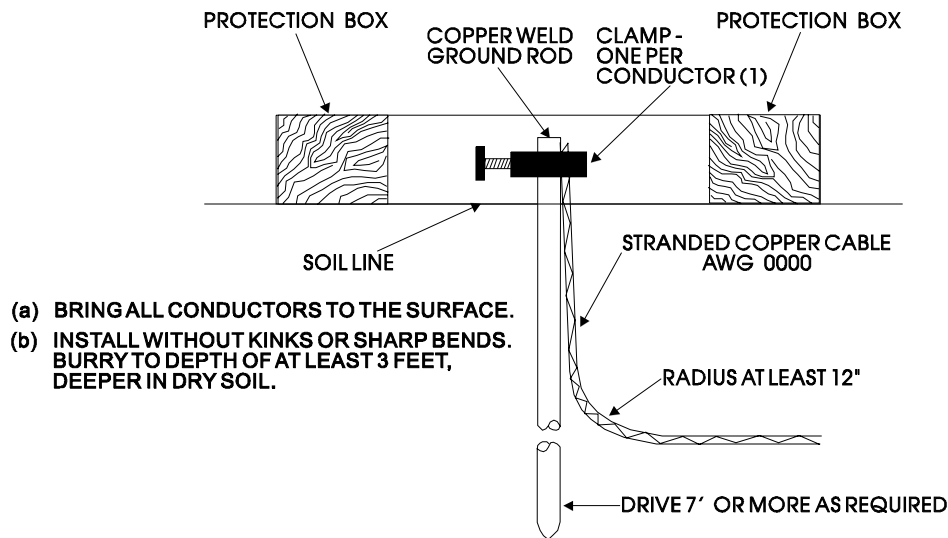
Figure 3-1 - Basic Ground Rod Installation

3.3.1.1 Soil Conditions

Before installing a ground rod, the soil type and moisture content should be analyzed. Ideally, the soil should be moist and moderately packed throughout to the depth of the ground rod. However, some soils will exhibit less than ideal conditions and will require extra attention.

Soil types can be placed into two general categories with respect to establishing and maintaining a good earth ground, i.e., 'Good Soil' and 'Poor Soil.'

To be a good conductor, soil must contain some moisture and free ions (from salts in the soil). In very rainy areas, the salts may be washed out of the soil. In very sandy or arid area the soil may be to dry and/or salt free to a good conductor. If salt is lacking add rock salt (NaCl); if the soil is dry add calcium chloride ($CaCl_2$).

3.3.1.2 Soil Types:

Good	Poor
Damp Loam	Back Fill
Salty Soil or Sand	Dry Soil
Farm Land	Sand Washed by a Lot of Rain
	Dry Sand (Desert)
	Rocky Soil

Ground Beds must always be tested for conductivity prior to being placed into service. A brief description of ground bed testing in 'Good Soil' and 'Poor Soil' is provided herein. Details on this test are described in the <u>National Electrical Code Handbook</u>. Once a reliable

ground has been established, it should be tested on a regular basis to preserve system integrity.
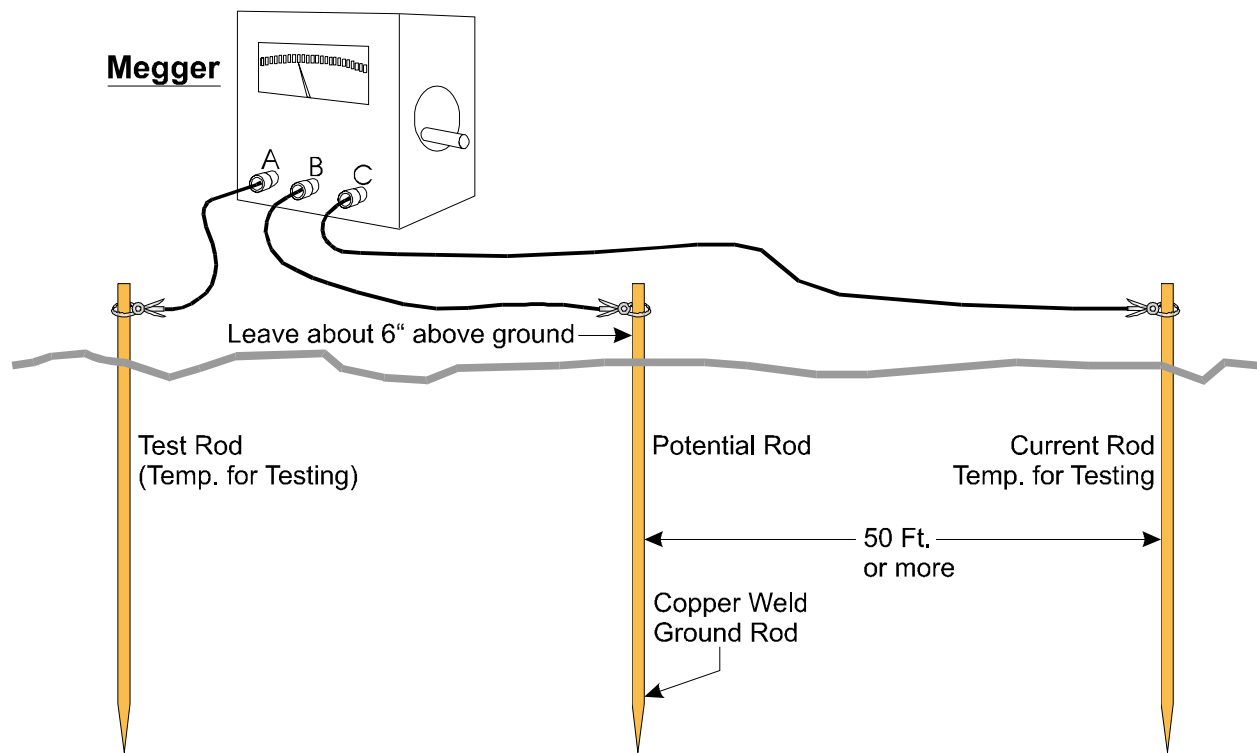

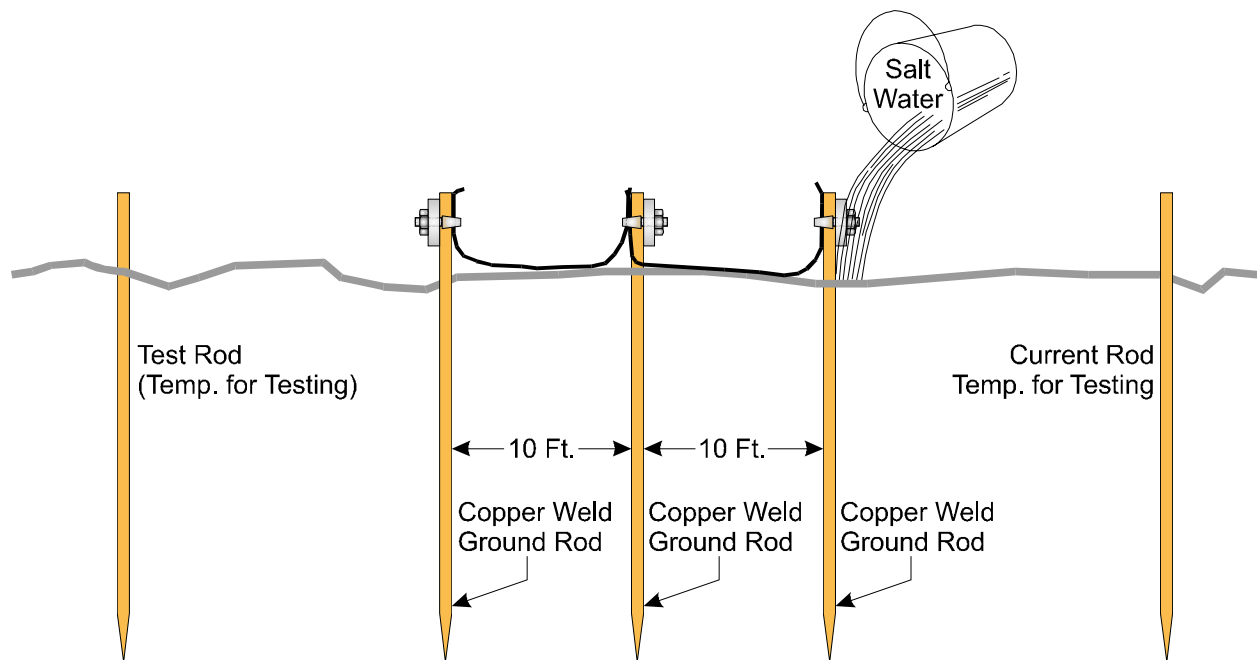**Figure 3-2 - Basic Ground Bed Soil Test Setup**

Figure 3-3 - Basic Ground Bed Soil Test Setup with Additional Ground Rods

Figure 3-2 shows the test setup for 'Good Soil' conditions. If the Megger* reads less than 5 ohms, the ground is good. The lower the resistance, the better the earth ground. If the

Megger reads more than 10 ohms, the ground is considered 'poor.' If a poor ground is indicated, one or more additional ground rods connected 10 feet from the main ground rod should be driven into the soil and interconnected via bare AWG 0000 copper wire and 1" x ¼-20 cable clamps as illustrated in Figure 3-3). *** Note: Megger is a Trademark of the Biddle Instrument Co. (now owned by AVO International). Other devices that may be used to test ground resistance are "Viboground"; Associated Research, Inc., "Groundmeter"; Industrial Instruments, Inc., and "Ground-ohmer"; Herman H. Sticht Co., Inc.**

If the Megger still reads more than 10 ohms, mix a generous amount of cooking salt, ice cream salt or rock salt with water and then pour about 2.5 to 5 gallons of this solution around each rod (including the test rods). Wait 15 minutes and re-test the soil. If the test fails, the soil is poor and a 'Poor Soil Ground Bed' will have to be constructed.

Figure 3-4 shows a typical Poor Soil Ground Bed Electrode. A Poor Soil Ground Bed will typically consists of four or more 10-foot long electrodes stacked vertically and separated by earth. Figure 3-5 shows the construction of a Poor Soil Ground Bed. For some poor soil sites, the ground bed will be constructed of many layers of 'Capacitive Couplings' as illustrated. In extremely poor soil sites one or more 3' by 3' copper plates (12 gauge or 1/16" thick) will have to be buried in place of the electrodes.
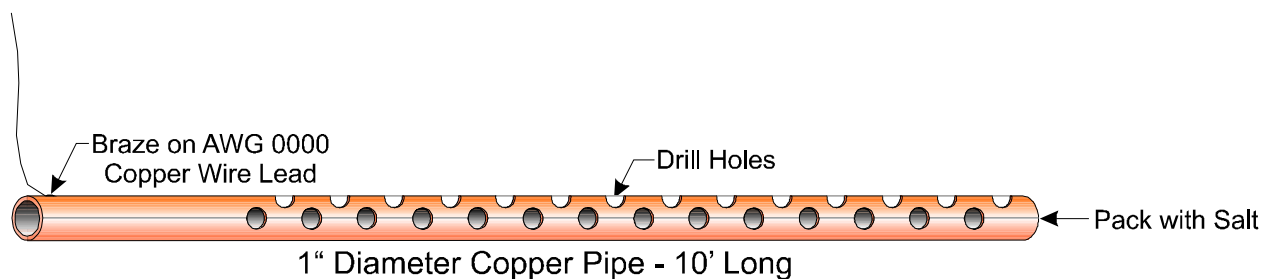

Figure 3-4 - Ground Electrode Construction for Poor Soil Conditions

3.3.1.3 Dry, Sandy or Rocky Soil

Very dry soil will not provide enough free ions for good conductance and a single ground rod will not be effective. A buried counterpoise or copper screen is recommended for these situations. It will be necessary to keep the soil moist through regular applications of water.

Sandy soil, either wet or dry, may have had its soluble salts leached out by rain water, thereby reducing conductivity of the ground. High currents from lightning strikes could also melt sand and cause glass to form around the ground rod, rendering it ineffective. A buried counterpoise or copper screen is preferred for these installations along with regular applications of salt water.

Rocky soil can pose many grounding problems. A counterpoise or copper plate will probably be required. Constructing a trench at the grounding site and mixing the fill with a hygroscopic salt such as calcium chloride may help for a time. Soaking the trench with water on a regular basis will maintain conductivity.

Units with phone modems require the use of a lightning arrester. The lightning arrester must be situated at the point where the communication line enters the building.
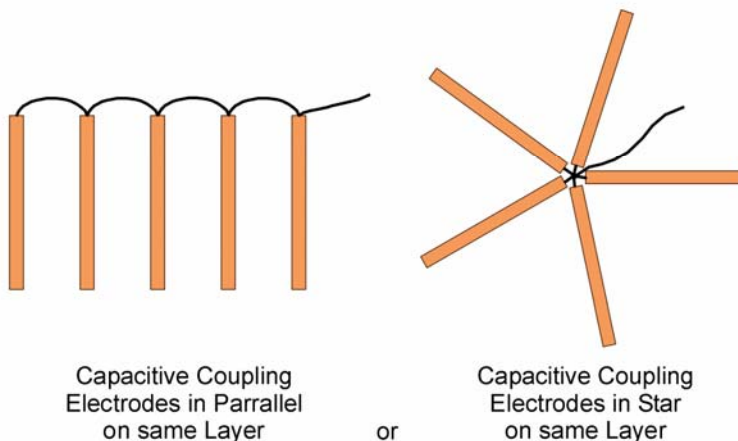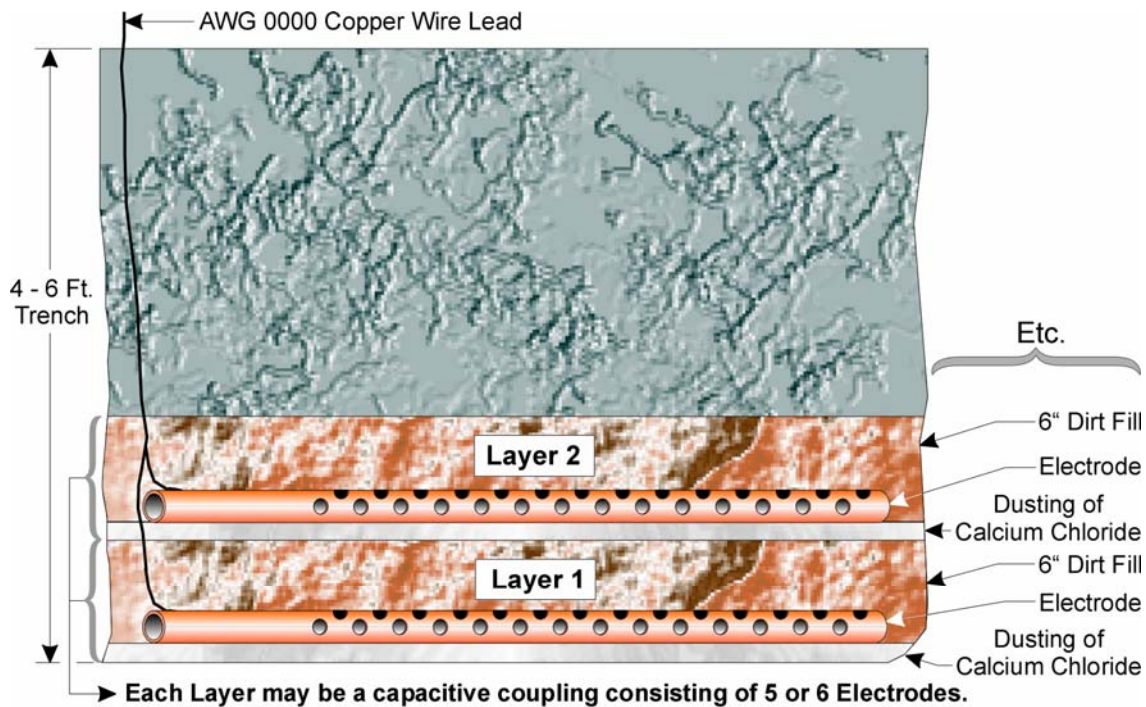
Figure 3-5 - Poor Soil Ground Bed Construction Diagram

3.3.2 Ground Wire Considerations

<u>**Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control**Wave**RED**, **Control**Wave **REDIO** & **Control**Wave I/O Expansion Rack</u>
ControlWave Chassis are provided with a Ground Lug that accommodates up to a #4 AWG wire size. A ground wire must be run between the Chassis Ground Lug and a known good Earth Ground. The cases of the various **Control**Wave Modules are connected to Chassis Ground when they have been installed and secured via their two Captured Panel Fasteners. As an extra added precaution, it is recommended that a #14 AWG wire be run from PSSM Power Connector TB2-5 (Chassis Ground) (PSSM Connector TB1-3 for **Control**Wave **MICRO** unit) (SCM Connector TB1-3 for **Control**Wave **EFM**) to the same known good Earth Ground.

<u>**Control**Wave**LP** Process Automation Controller</u>
A #14 AWG ground wire must be run from the **Control**Wave**LP**'s PSSB Terminal TB2-3 (Chassis Ground) to a known good Earth Ground. In lieu of a direct connection to Earth

Ground, it is recommended that the unit's Chassis Ground Terminal be connected to a conductive mounting panel or plate, a user supplied Ground Lug or a user supplied Ground Bus. The panel, lug or bus in turn must be connected to a known good Earth Ground via a #4 AWG wire.

General Considerations
The following considerations are provided for the installation of **Control**Wave system grounds:

- Size of ground wire (running to Earth Ground should be #4 AWG. It is recommended that stranded copper wire is used for this application and that the length should be as short as possible.
- This ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a stranded copper AWG 0000 cable installed vertically or horizontally).
- The wire ends should be tinned with solder prior to installation.
- The ground wire should be run such that any routing bend in the cable has a minimum radius of 12-inches below ground and 8-inches above ground.

The units Earth Ground Cable should be clamped to an exposed Ground Rod or to an AWG 0000 stranded copper Ground Cable that in turn should be connected to either an Earth Ground Rod or Earth Ground Bed. Both ends of the units Earth Ground Cable must be free of any coating such as paint or insulated covering as well as any oxidation. The connecting point of the Ground Rod or AWG 0000 Ground Cable must also be free of any coating and free of oxidation. Once the ground connection has been established (at either the Ground Rod or Ground Cable) it should be covered or coated to protect it from the environment.

3.3.3 Other Grounding Considerations

Figure 3-6 - Grounding of Phone Line

For applications employing equipment that communicates over telephone lines, a lightning arrester **Must Be** provided. For indoor equipment the lightning arrester must be installed a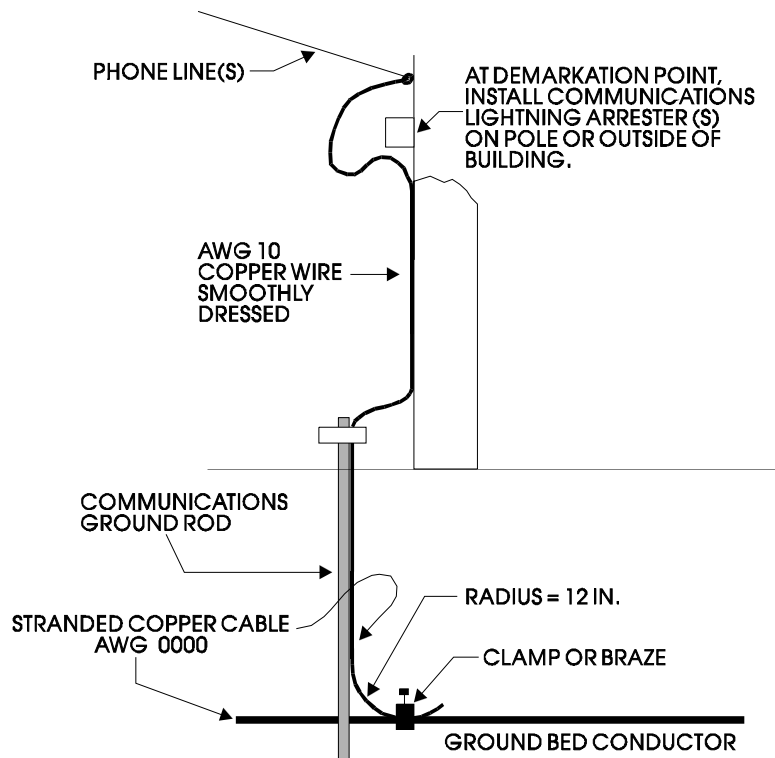t the point where the communication line enters the building as shown in Figure 3-6. The ground terminal of this arrester must connect to a ground rod and/or a buried ground bed.

Gas lines also require special grounding considerations. If a gas meter run includes a thermocouple or RTD sensor installed in a thermowell, the well (not the sensor) must be connected to a gas discharge-type lightning arrester as shown in Figure 3-7. A copper braid, brazed to the thermal well, is dressed into a smooth curve and connected to the arrester as shown. The curve is necessary to minimize arcing caused by lightning strikes or high static surges. The path from the lightning arrester to the ground bed should also be smooth and free from sharp bends for the same reason.
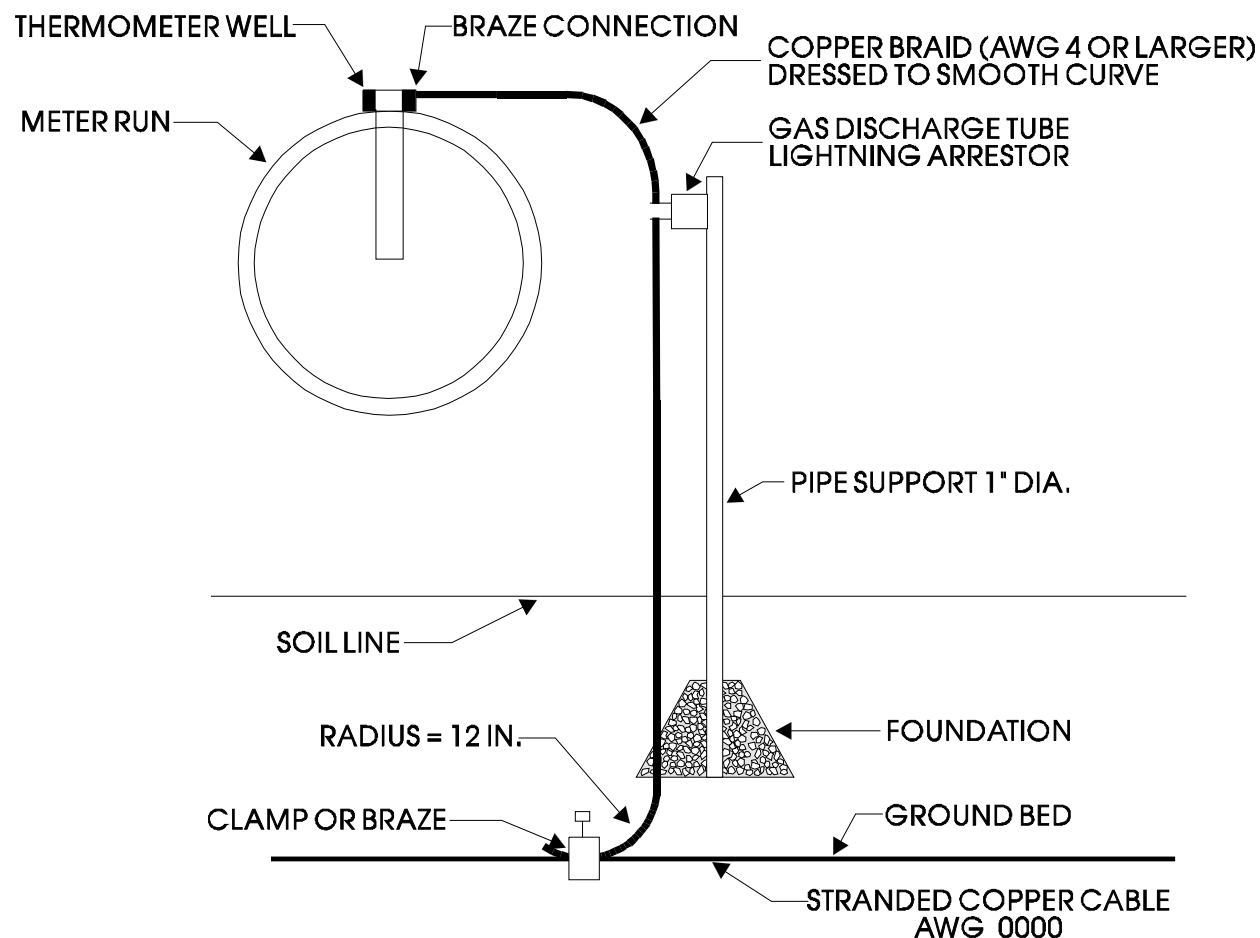
Figure 3-7 - Grounding of Thermometer Well in Gas Line

3.4 ISOLATING EQUIPMENT FROM THE PIPELINE

3.4.1 Meter Runs Without Cathodic Protection

ControlWave **EFM/GFC/XFC**'s may be mounted directly on the pipeline or remotely on a vertical stand-alone two-inch pipe (see Figure 3-8). The Earth Ground Cable is to run between the **Control**Wave **EFM/GFC/XFC**'s Ground Lug and Earth Ground (Rod or Bed) even though the **Control**Wave **EFM/GFC/XFC**'s Multivariable Transducer may be

grounded to the pipeline. If any pressure transmitters or pulse transducers are remotely mounted, connect their chassis grounds to the pipeline or earth ground.

AWG 4 Ground Wire

2" Pipe-mounting Package

Clamp(s)

Ground Rod or System
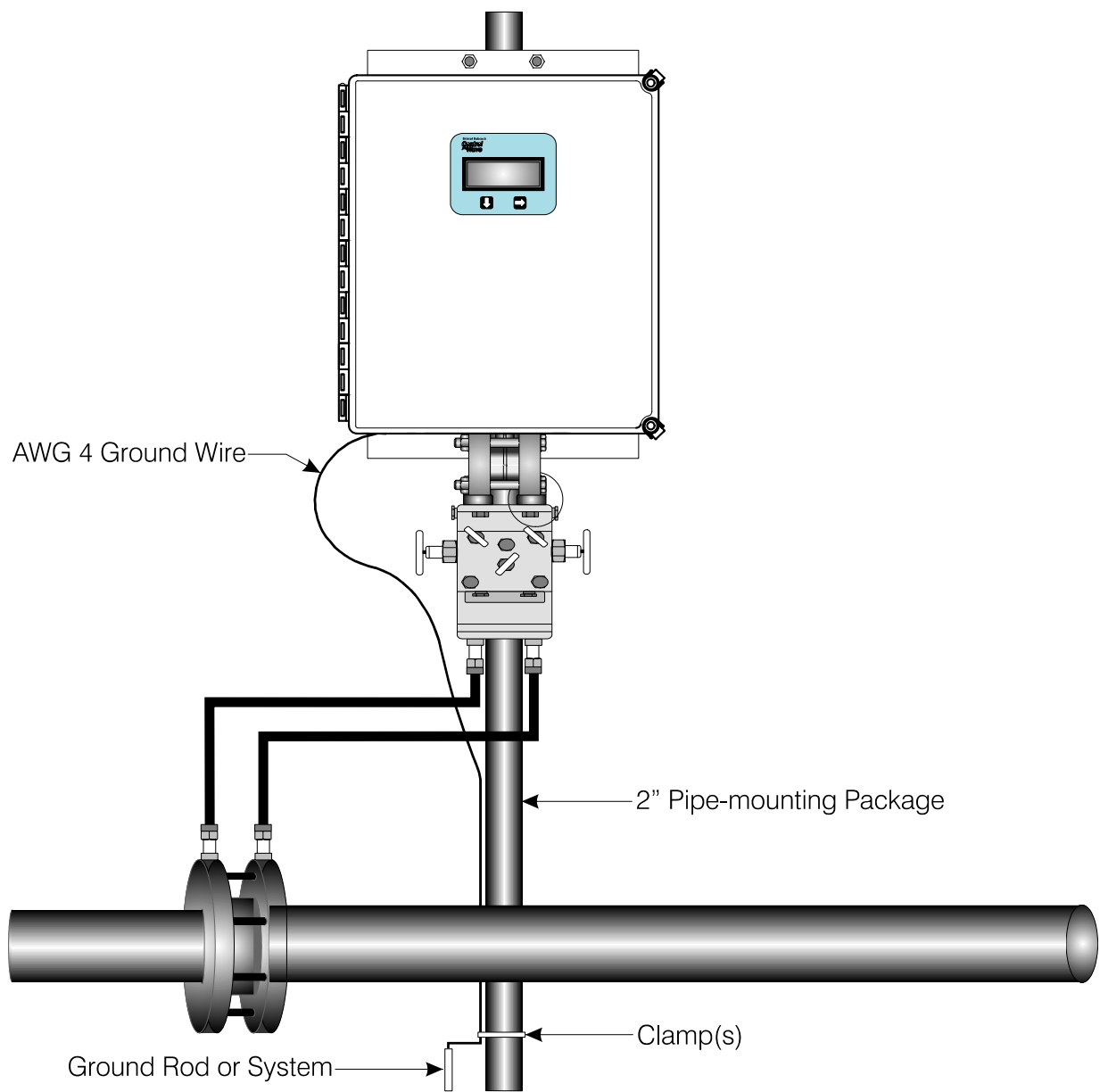
Figure 3-8 - Control Wave **EFM (Installation is similar to GFC/XFC)**
Remote Installation without Cathodic Protection

3.4.2 Meter Runs With Cathodic Protection

Dielectric isolators are available from Bristol Babcock and are always recommended as an *added measure* in isolating the **Control**Wave **EFM/GFC/XFC** from the pipeline even though the **Control**Wave **EFM/GFC/XFC** does provide 500V galvanic isolation from the pipeline and should not be affected by cathodic protection or other EMF on the pipeline. **Control**Wave **EFM/GFC/XFC** may be mounted directly on the pipeline (see Figure 3-9) or remotely on a vertical stand-alone two-inch stand-pipe (see Figure 3-10). It is recommended that isolation fitting always be used in remotely mounted meter systems. An isolation fittings or gasket should be installed between the following connections:

- all conductive tubing that runs between the pipeline and mounting valve manifold and/or the units multivariable pressure transducer
- all conductive connections or tubing runs between the **Control**Wave **EFM/GFC** and turbine meter, pulse transducer, or any input other device that is mounted on the pipeline
- any Temperature Transducer, Pressure Transmitter, etc. and their mount/interface to the pipeline
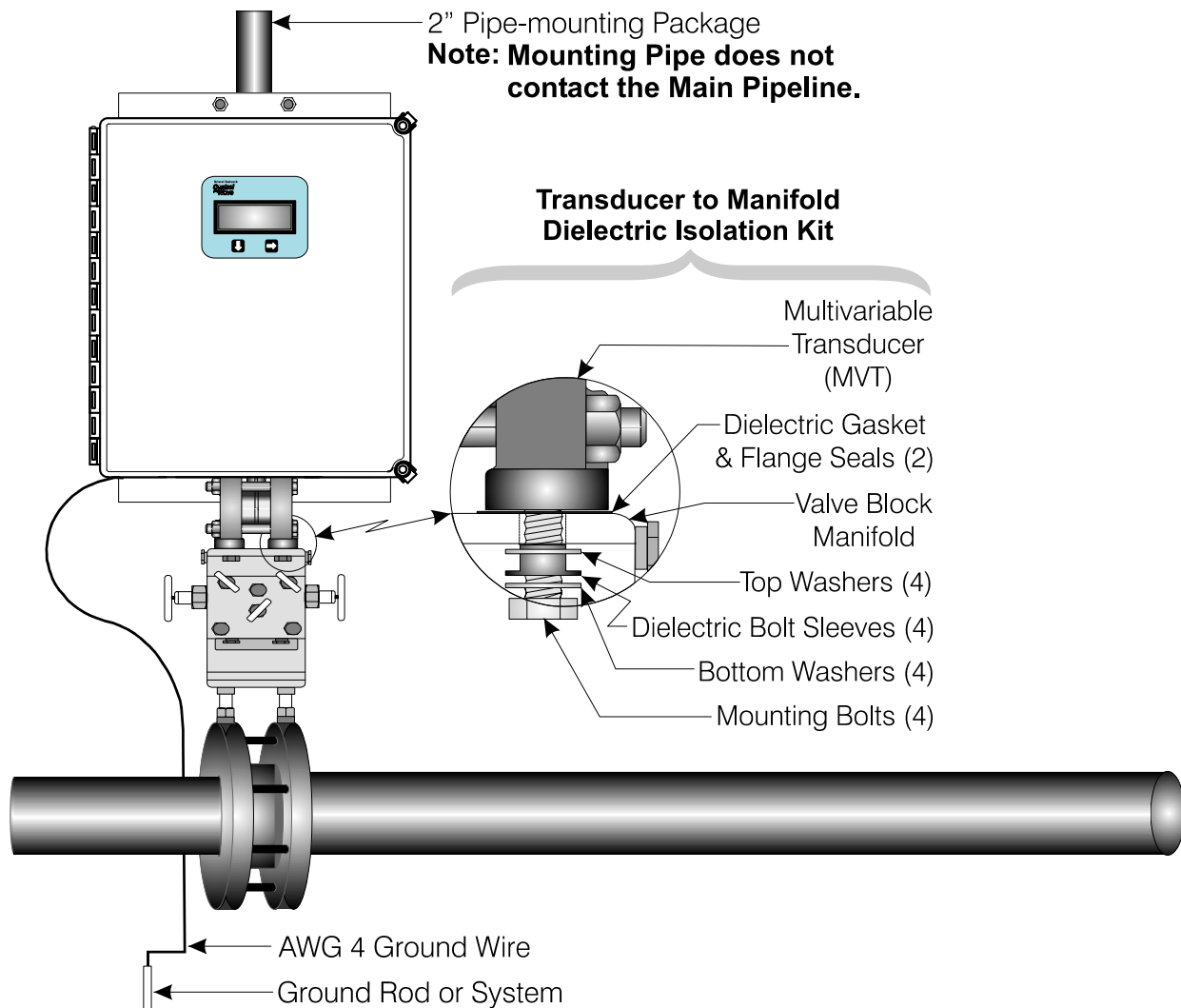
Figure 3-9 - Control Wave **EFM (Installation is similar to EFM/GFC/XFC)**
Direct Mount Installation (with Cathodic Protection)

The ground conductor connects between the **Control**Wave **EFM/GFC/XFC**'s Ground Lug and a known good earth ground. Connect the cases of Temperature Transducers, Pressure Transmitters, etc., to the known good earth ground. If the mounting 2-inch pipe is in continuity with the pipeline it will have to be electrically isolated from the **Control**Wave **EFM/GFC/XFC**. Use a strong heat-shrink material such as RAYCHEM WCSM 68/22 EU 3140. This black tubing will easily slip over the 2-inch pipe and then after uniform heating (e.g., with a rose-bud torch) it electrically insulates and increases the strength of the pipe stand.

See BBI Specification Summary F1670SS-0a for information on PGI Direct Mount Systems and Manifolds.

Transducer to Manifold Dielectric Isolation Kit

- Multivariable Transducer (MVT)
- Dielectric Gasket & Flange Seals (2)
- Valve Block Manifold
- Top Washers (4)
- Dielectric Bolt Sleeves (4)
- Bottom Washers (4)
- Mounting Bolts (4)

AWG 4 Ground Wire

Isolating Fittings

2" Pipe-mounting Package
Note: Mounting Pipe does not contact the Main Pipeline.

Clamp(s)

Ground Rod or System

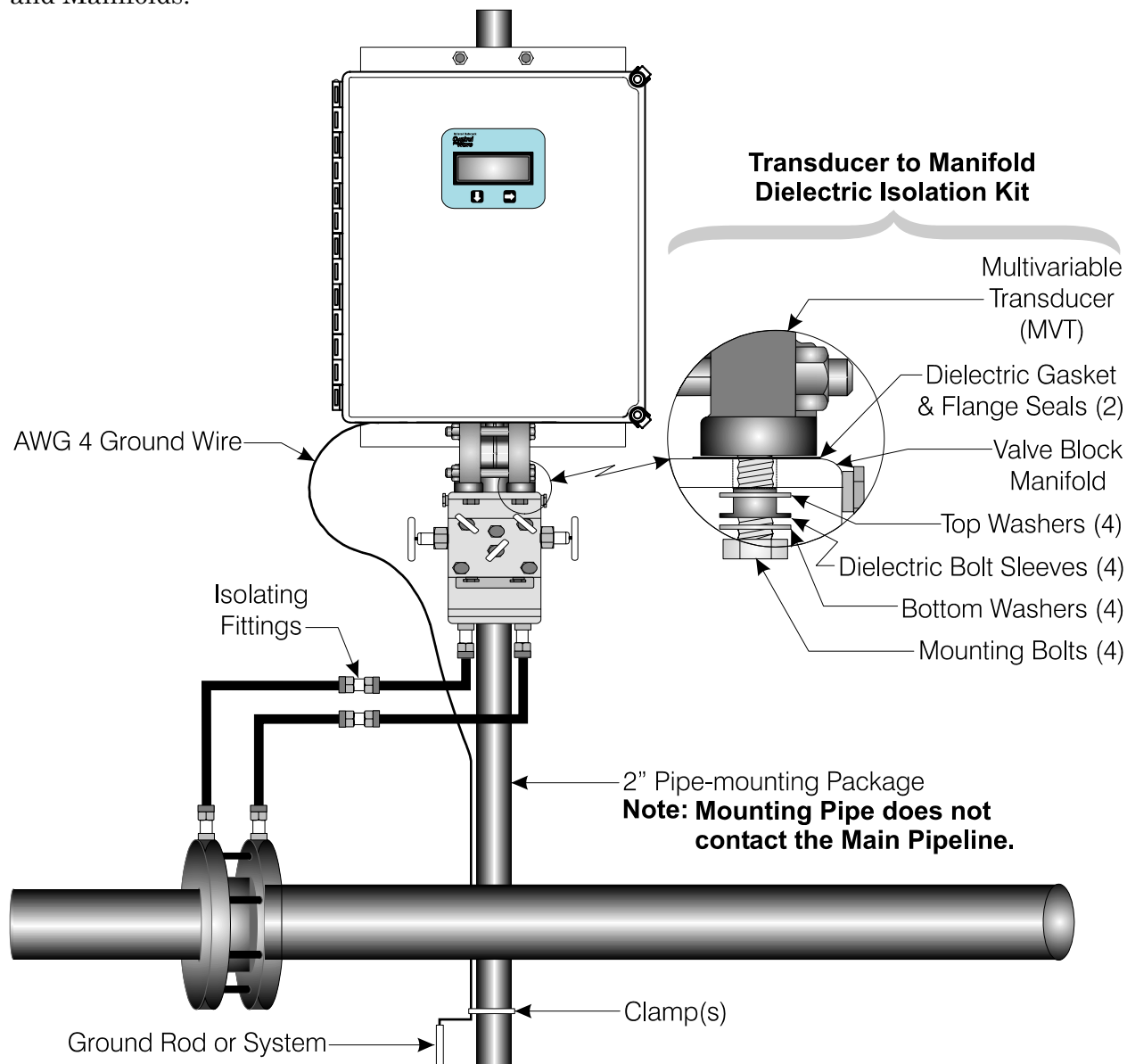**Figure 3-10 – Control**Wave **EFM (Installation is similar to GFC/XFC) Remote Installation (with Cathodic Protection)**

Section 4 - Lightning Arresters & Surge Protectors

4.1 STROKES & STRIKES

Lightning takes the form of a pulse that typically has a 2 µS rise and a 10 µS to 40 µS decay to a 50% level. The IEEE standard is an 8 µS by 20 µS waveform. The peak current will average 18 KA for the first impulse and about half of that for the second and third impulses. Three strokes (impulses) is the average per lightning strike. The number of visible flashes that may be seen is not necessarily the number of electrical strokes.

A lightning strike acts like a constant current source. Once ionization occurs, the air becomes a luminous conductive plasma reaching up to 60,000° F. The resistance of a struck object is of little consequence except for the power dissipation on the object (I^2 x R). Fifty percent of all lightning strikes will have a first impulse of at least 18 KA, ten percent will exceed the 60 KA level, and only about one percent will exceed 120 KA.

4.1.1 Chance of Being Struck by Lightning

The map of Figure 4-1 shows the average annual number of thunderstorm days (Isokeraunic level) for the various regions within the continental U.S.A. This map is not representative of the severity of the storm or the number of lightning strikes since it does not take into account more than one lightning strike in a thunderstorm day. The Isokeraunic or Isoceraunic number provides a meteorological indication of the frequency of thunderstorm activity; the higher the Isokeraunic number the greater the lightning strike activity for a given area. These levels vary across the world from a low of 1 to a high of 300. Within the United States the Isokeraunic level varies from a low of 1 to a high of 100.
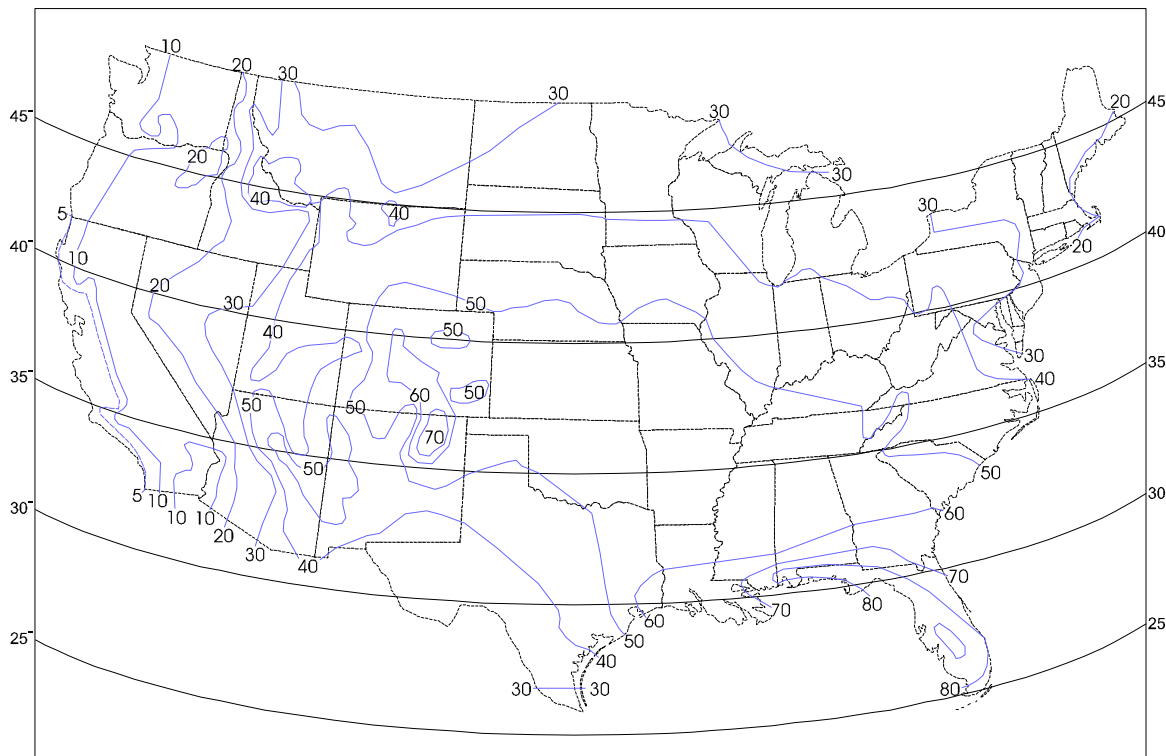

Figure 4-1 - Average Thunderstorm Days of the Year (for Continental USA)

Thunderstorms are cloud formations that produce lightning strikes (or strokes). Across the United States there is an average of 30 thunderstorm days per year. Any given storm may produce from one to several strokes. Data on the subject indicates that for an average area within the United States there can be eight to eleven strokes to each square mile per year. The risk of stroke activity is increased for various areas such central Florida where up to 38 strokes to each square mile per year are likely to occur.

To determine the probability of a given structure (tower, building, etc.) (within your location) being struck, perform the following computation:

1. Using the map of Figure 4-1 (or a comparable meteorological map for your local), find the Isokeraunic level (I) for your area. Then using Chart 1, find "A" for your area.
2. Refer to Figure 4-1 to find the latitude. Then using Chart 2, find "B" for your latitude (Lat.°).
3. Multiply "A" x "B" to get "C".
4. To calculate the number of lightning strikes per year that are likely to strike a given object (tower, mast, etc.), use the equation that follows (where "C" was calculated in step 3 and "H" is equal to the height of the object.

Strikes Per Year = ("C" x H^2) ÷ (.57 x 10^6)

Chart 1			Chart 2	
I	"A"		LAT.°	"B"
5	8		25	.170
10	26		30	.200
20	85		35	.236
30	169		40	.280
40	275		45	.325
50	402			
60	548			
70	712		**Note for these charts:**	
80	893		I = Thunderstorm Days Per Year (Isokeraunic Number)	
90	1069		A= Stroke activity for associated Isokeraunic Area	
100	1306		B= Height/Stroke coefficient for associated latitude	

For Example: On Long Island, New York (Isokeraunic number 20), Chart 1 gives "A" to equal 85. The latitude is approximately 40°. Referring to Chart 2, "B" is found to be equal to .28. "C" for this example is equal to 23.80. Using the equation for strikes per year, it is determined that a 100-foot tower has .4 chances per year of being struck by lightning. Assuming that no other structures are nearby, the tower will more than likely be struck by lightning at least once in three years.

Note: The Isokeraunic activity numbers connoted as I, "A" and "B" in Charts 1 and 2 above are provided for the continental United States. Isokeraunic data for various countries is available from various federal or state Civil Engineering or Meterorelogical organizations. This information is typically available from manufacturers of lightning strike protection equipment (such as Lightning Arresters).

Since **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control-**Wave**LP** and **Control**Wave**EXP** units are dc operated systems that are isolated from AC grids, they are typically immune to lightning strikes to power lines or power equipment (except for inductive flashover due to close installation proximity). However, once a radio or

modem has been interfaced to a **Control**Wave, **Control**Wave **MICRO**, **Control**Wave **EFM/GFC/XFC**, **Control**Wave**LP**, or **Control**Wave**EXP** the possibility of damage due to a lightning strike on power or telephone lines or to a radio antenna or the antenna's tower must be considered. It is recommended that the additional lightning protection considerations listed below be followed for units installed in areas with a high possibility or history of stroke activity.

Units interfaced to a modem: In series with the phone line (as far away as possible from the equipment) - for indoor installations the lightning arrester should typically be located at the point where the line enters the structure.

Units interfaced to a radio: Mount antenna discharge unit (lightning arrester) as close as possible to where the lead in wire enters the structure. See Antenna Caution below.

4.1.2 Antenna Caution

Each year hundreds of people are killed, mutilated, or receive severe permanent injuries when attempting to install or remove an antenna or antenna lead. In many cases, the victim was aware of the danger of electrocution but failed to take adequate steps to avoid the hazard. For your safety, and for proper installation maintenance, please **read** and **follow** the safety precautions that follow - **they may save your life**.

- When installing or servicing an antenna:
  DO NOT use a metal ladder. DO NOT step onto or touch an antenna mast while power is applied to an associated radio unless the radio is a low power (low current) type.
  DO NOT work on a wet or windy day, especially during a thunderstorm or when there is lightning or thunder in your area. Dress properly; shoes with rubber soles and heels, rubber gloves, long sleeve shirt or jacket.
- The safe distance from power lines should be at least twice the height of the antenna and mast combination.
- Antenna Grounding per National Electrical Code Instructions:
  A. Use AWG 10 or 8 aluminum or AWG 1 copper-clad steel or bronze wire, or larger as ground wires for both the mast and lead-in. Securely clamp the wire to the bottom of the mast.
  B. Secure lead-in wire from antenna to antenna discharge (lightning arrester) unit and the mast ground wire to the structure (building, shed, etc.) with stand-off insulators spaced from 4 feet (1.22 meters) to 6 feet (1.83 meters) apart.
  C. Mount antenna discharge unit as close as possible to where the lead-in wire enters the structure.
  D. The hole drilled through the wall for the lead-in wire should be just large enough to accommodate the cable. Before drilling this hole, make sure there are no wires or pipes, etc. in the wall.
  E. Push the cable through the hole and form a rain drip loop close to where the wire enters the exterior of the structure.
  F. Caulk around the lead-in wire (where it enters the structure) to keep out drafts.
  G. Install lightning arresters (antenna discharge units). The grounding conductor should be run in as straight a line as practicable from the antenna mast and/or the antenna discharge units to grounding electrode(s).
  H. Only connect the antenna cable to the radio after the mast has been properly grounded and the lead-in cable has been properly connected to lightning arresters which in turn have each been properly connected to a known good earth ground.
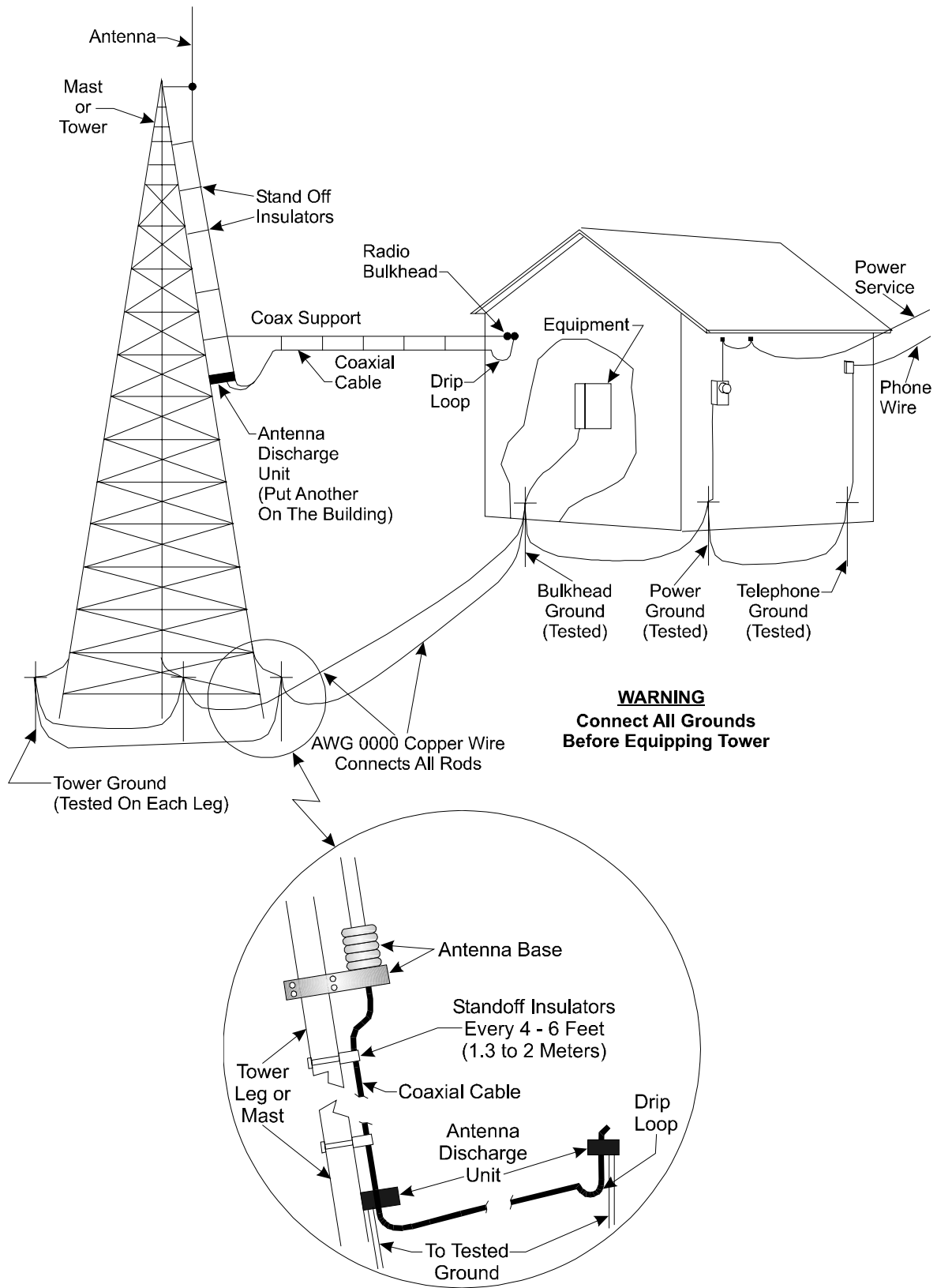
Figure 4-2 - Radio Antenna Field Installation Site Grounding Diagram

For all systems it is best to have all communication equipment input/output grounds tied together. In the case of **Control**Wave units, this is accomplished via the unit's Chassis Ground (Typically at a ground lug, ground bus or ground plate). However additional

communication equipment lightning arresters and surge suppressors should be tied to the same system ground. System ground consists of the tower leg grounds utility ground and bulkhead-equipment ground-stakes that are tied together via bare copper wire.

4.1.3 Ground Propagation

As in any medium, a dynamic pulse, like R.F., will take time to propagate. This propagation time will cause a differential step voltage to exist in time between any two ground rods that are of different radial distances from the strike. With a ground rod tied to a struck tower, the impulse will propagate its step voltage outwardly from this rod in ever-expanding circles, like a pebble thrown into a pond. If the equipment house has a separate ground rod and the power company and/or telephone company grounds are also separate, the dynamic step voltage will cause currents to flow to equalize these separate ground voltages. Then if the coax cable (associated with a radio) is the only path linking the equipment chassis with the tower ground, the surge can destroy circuitry.

4.1.4 Tying it all Together

To prevent this disaster from occurring, a grounding system must be formed which interconnects all grounds together. This will equalize and distribute the surge charge to all grounds, and at the same time, it will make for a lower surge impedance ground system. This interconnection can be done as a grid, where each ground has a separate line to each other ground, or by using a "rat Race" ring which forms a closed loop (not necessarily a perfect circle) which surrounds the equipment house completely.

By making this interconnection, it will be necessary to use proper I/O protectors for the equipment. Of course, these should be a requirement regardless of whether this grounding technique is used. I/O protectors are used for power lines (even those these don't feed into a **Control**Wave unit), telephone lines, and also to minimize EMI pick-up from a strike. Ideally it is best to place all I/O protectors on a common panel that has a low inductance path to the ground system. The **Control**Wave units would then have a single ground point from its Chassis Ground Terminal/Ground Lug to this panel. In lieu of this, the **Control**Wave unit in question should be tied to a ground rod that in turn is connected to the Earth/System Ground created for the site.

Your protected equipment connected to a common single ground system, will now be just like a bird sitting on a high tension wire. When lightning strikes, even with a 50 ohm surge impedance ground system, the entire system consisting of equipment, ground system, building, etc., will all rise together to the one million volt peak level (for example) and will all decay back down together. So long as there is no voltage differential (taken care of by protectors and ground interconnections, there will be no current flow through the equipment and therefore no resulting equipment damage.

4.1.5 Impulse Protection Summary

- Use more than one ground rod.
- Place multi-ground stakes more than their length apart.
- Tie Power, Telco, Tower, Bulkhead and equipment ground together.
- Make all ground interconnect runs that are above ground with minimum radius bends of eight inches and run them away from other conductors and use large solid wire or a solid strap.

- Watch out for dissimilar metals connections and coat accordingly.
- Use bare wire radials together where possible with ground stakes to reduce ground system impedance.
- Use I/O protectors (Phone line, Radio) with a low inductance path to the ground system.
- Ground the Coaxial Cable Shield (or use an impulse suppressor) at the bottom of the tower just above the tower leg ground connection.

4.2 USE OF LIGHTNING ARRESTERS & SURGE PROTECTORS

Units equipped with radios or modems use lightning arresters and surge protectors to protect equipment from lightning strikes, power surges and from damaging currents that have been induced onto communication lines.

The first line of defense is the <u>Lightning Arrester</u>. These devices typically use gas discharge bulbs that can shunt high currents and voltages to earth ground when they fire. The high current, high voltage gas discharge bulb has a relatively slow response time and only fire when their gas has been ionized by high voltage.

The second line of defense is the <u>Surge Protector</u>, which is made of solid state devices, fires very quickly and conducts low voltages and currents to ground. Surge protectors are built into BBI 9600 bps modems.

Lightning Arresters are applied to circuits as follows:

- Equipment or circuits that can be exposed to lightning strikes, falling power lines, high ground currents caused by power system faults, by operational problems on electric railways, etc.

- Equipment installed in dry, windy areas, such as the Great Plains and the Southwest Desert in the United States. Wind and wind blown dust can cause high voltages (static) to appear on overhead wires, fences, and metal buildings.

Note: Lightning Arresters may explode if lightning strike is very close. Mount lightning arresters where flying parts won't cause injury to equipment or personnel.

Section 5 - Wiring Techniques

5.1 OVERVIEW

This section provides information pertaining to good wiring practices. Installation of Power and "Measurement & Control" wiring is discussed. Information on obscure problems, circulating ground and power loops, bad relays, etc. is presented. Good wire preparation and connection techniques along with problems to avoid are discussed.

5.2 INSTRUMENT WIRING

Each of the rules listed below is briefly discussed; the emphasis herein is placed on the avoidance of problems as well as equipment safety.

Rule 1 - Never utilize common returns.

Rule 2 - Use twisted shielded pairs (with overall insulation) on all Signal/Control circuits.

Rule 3 - Ground cable shields at one end only.

Rule 4 - Use known good earth grounds (Rod, Bed, System) and test them periodically,

Rule 5 - Earth connections must utilize smoothly dressed large wire.

Rule 6 - Perform all work neatly and professionally.

Rule 7 - Route high power conductors away from signal wiring according to NEC Rules.

Rule 8 - Use appropriately sized wires as required by the load.

Rule 9 - Use lightning arresters and surge protectors.

Rule 10 - Make sure all wiring connections are secure.

5.2.1 Common Returns

Use of common returns on I/O wiring is one of the most common causes of obscure and difficult to troubleshoot control signal problems. Since all wires and connections have distributed resistance, inductance and capacitance, the chances of a achieving a balanced system when common returns are present is very remote. Balanced systems (or circuits) are only achieved when all currents and voltages developed in association with each of the common returns are equal. In a balanced system (or circuit) there are no noise or measurment errors introduced due to by "sneak circuits."

The illustration of Figure 5-1 shows the difference between testing an I/O circuit that is discrete and has no sneak circuits and one that utilizes common returns. Common sense tells us that it is tough to mix up connections to a twisted shielded pair (with overall vinyl covering) to every end device. Do yourself a favor; to make start up easier, DON'T USE COMMON RETURNS!

Field Wired Circuit Without A Common Return

Meter

End Device

NOTE:
Without A Common Return
There are No Sneak Circuits
&
Testing Is Easy.
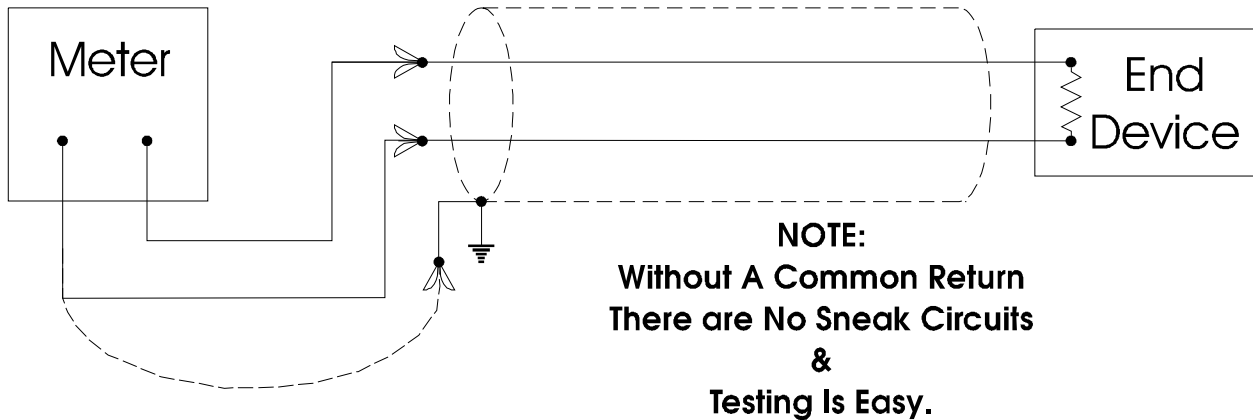
Field Wired Circuit With A Common Return

Source 1

2

3

4

5

Common

NOTE:
With A Common Return
Sneak Circuits Are Created!
A Lot Of Equipment Must Be
Disconnected To Find A Sneak Circuit!!!
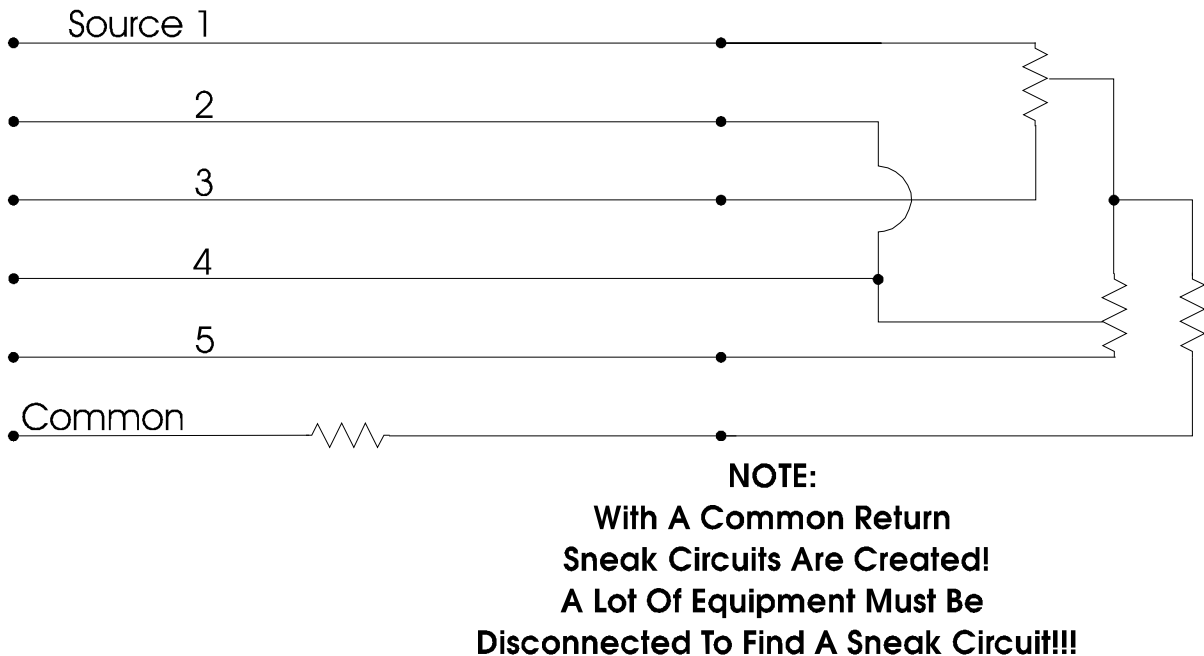
Figure 5-1 - Field Wired Circuits With & Without A Common Return

5.2.2 Use of Twisted Shielded Pair Wiring (with Overall Insulation)

For all field I/O wiring the use of twisted shielded pairs with overall insulation is highly recommended. This type of cable provides discrete insulation for each of the wires and an additional overall insulated covering that provides greater E.M.I. immunity and protection to the shield as well.

5.2.3 Grounding of Cable Shields

DO NOT connect the cable shield to more than one ground point; it should only be grounded at one end. Cable shields that are grounded at more than one point or at both ends may have a tendency to induce circulating currents or sneak circuits that raise havoc with I/O signals. This will occur when the ground systems associated with multipoint connections to a cable shield have a high resistance or impedance between them and a ground induced voltage is developed (for what ever reason, i.e., man made error or nature produced phenomena).

5.2.4 Use of Known Good Earth Grounds

ControlWave units should only have one connection to earth ground. For **Control**Wave and **Control**Wave **MICRO** Process Automation Controllers, **Control**Wave **MICRO**, **Control**Wave **EFM** Electronic Flow Meters, **Control**Wave **GFC/XFC** Gas Flow Computers and **Control**Wave I/O Expansion Racks, this connection is provided via the Ground Lug that is situated on the bottom of the unit. **Control**Wave**LP**s require the installation of a ground lug, ground bus or ground plate/panel. Since **Control**Wave units are DC-based systems, grounding does not take into account AC power grounding considerations. Earth grounding the unit is absolutely necessary when the unit is equipped with a radio or modem. Additionally these units should be connected to earth ground when they are installed in areas that have frequent lightning strikes or are located near or used in conjunction with equipment that is likely to be struck by lightning or if struck by lightning may cause equipment or associated system failure. Earth Grounds must be tested and must be known to be good before connecting the **Control**Wave. Earth grounds must be periodically tested and maintained (see Section 4).

5.2.5 Earth Ground Wires

Earth connections must utilize smoothly dressed large wire. Use AWG 3 or 4 stranded copper wire with as short a length as possible. Exercise care when trimming the insulation from the wire ends. Twists the strands tightly, trim off any frizzes and tin the ends with solder. The earth ground wire should be clamped or brazed to the Ground Bed Conductor (that is typically a standard AWG 0000 copper cable. The earth ground wire should be run such that any routing bend in the cable is a minimum 8-inch radius above ground or a minimum 12-inch radius below ground.

5.2.6 Working Neatly & Professionally

Take pride in your work and observe all site and maintenance safety precautions. After properly trimming the stranded pair wire ends, twist them in the same direction as their manufacturer did and then tin them with solder. Install the tinned wire end into it's connector and then secure the associated connector's clamping screw. Remember to check these connections for tightness from time to time. If solid copper wire is used (in conjunction with the DC Power System or for Earth Ground) make sure that the conductor is not nicked when trimming off the insulation. Nicked conductors are potential disasters waiting to happen. Neatly trim shields and whenever possible, coat them to protect them and prevent shorts and water entry.

Remember loose connections, bad connections, intermittent connections, corroded connections, etc., are hard to find, waste time, create system problems and confusion in addition to being costly.

5.2.7 High Power Conductors and Signal Wiring

When routing wires, keep high power conductors away from signal conductors. Space wires appropriately to vent high voltage inductance. Refer to the National Electrical Code Handbook for regulatory and technical requirements.

5.2.8 Use of Proper Wire Size

ControlWaves utilize compression-type terminals that accommodate up to #14 AWG gauge wire. A connection is made by inserting the bared end (1/4 inch max.) into the clamp beneath the screw and securing the screw.

Allow some slack in the wires when making terminal connections. Slack makes the connections more manageable and minimizes mechanical strain on the PCB connectors. Provide external strain relief (utilizing Tie Wrap, etc.) to prevent the loose of slack at the **Control**Wave.

Be careful to use wire that is appropriately sized for the load. Refer to equipment manufacturer's Specs. and the National Electrical Code Handbook for information on wire size and wire resistance. After installing the field wiring, test each load to determine if the correct voltage or current is present at the load. If you know the resistance of the field wires (Circular Mills x Length) you should be able to calculate the load voltage. Conversely, if you know the minimum load voltage and current, you should be able to derive the maximum voltage loss that is allowable due to line resistance and then the correct wire size.

Referring to Figure 5-2, a relay that is picked by 100 mA, with a loop supply voltage of 24V and a total line resistance of 20 ohms, the load voltage (voltage across the relay) should be:

$$V_L = V_S - (V_C + V_C) \quad \text{where} \quad V_C + V_C = (R_C + R_C)\ I$$
$$22 = 24 - 2 \quad \text{where} \quad 2V = (20\ \Omega) \times 0.1\ A$$

$$V_S = V_C + V_C + V_L$$

V_C is the loss in the conductor. It is equal to the Resistance of the Conductors times the Current through them.
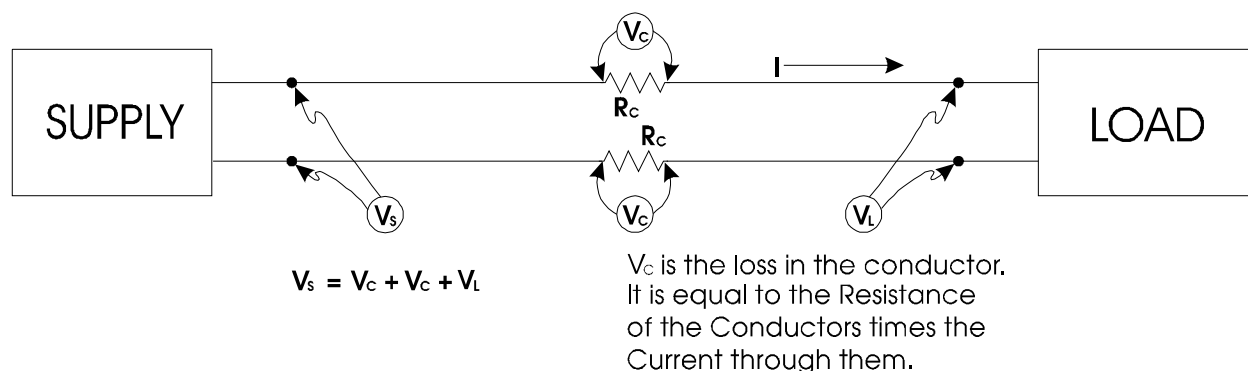
Figure 5-2 - Calculating Load Voltage due to Line Resistance

5.2.9 Lightning Arresters & Surge Protectors

Use lightning arresters in association with any radio or modem equipped unit. BBI 9600 bps modems are equipped with surge protection circuitry. Lightning arresters or Antenna

Discharge Units should be placed on the base of the antenna and at the point where the antenna lead (typically coax) enters the site equipment building. When a modem is used, a lightning arrester should be placed at the point where the phone line enters the site equipment building. If you use a modem (manufactured by other than BBI) it is recommended that you also install a surge suppressors or lightning arrester on the phone line as close to the modem as possible. *Any unit interfaced to a radio or modem must be connected to a known good earth ground.*

5.2.10 Secure Wiring Connections

Make sure that all wiring connections are secure. In time wires that were once round will become flattened due to the pressure applied by screw compression type terminals and site vibrations. After a while these compression screws have a tendency to become loose. Part of a good maintenance routine should be to check and tighten all screws associated with wiring terminal connections. Avoid nicking the wire(s) when stripping insulation. Remember, nicked conductors will lead to future problems. Also remember to provide some cabling slack and strain relief.

If installing stranded or braided wiring that has not been tinned, be sure to tightly twist the end (in the same direction as manufactured) and then trim off any frizzed wires.

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DOCUMENT NUMBER: S1400CW

TITLE: *ControlWave^{TM} SITE CONSIDERATIONS For EQUIPMENT INSTALLATION, GROUNDING & WIRING*

ISSUE DATE: APR., 2005

COMMENT/COMPLAINT:

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RC Rev: 05-Feb-04

CARE AND HANDLING
OF
PC BOARDS
AND
ESD-SENSITIVE
COMPONENTS

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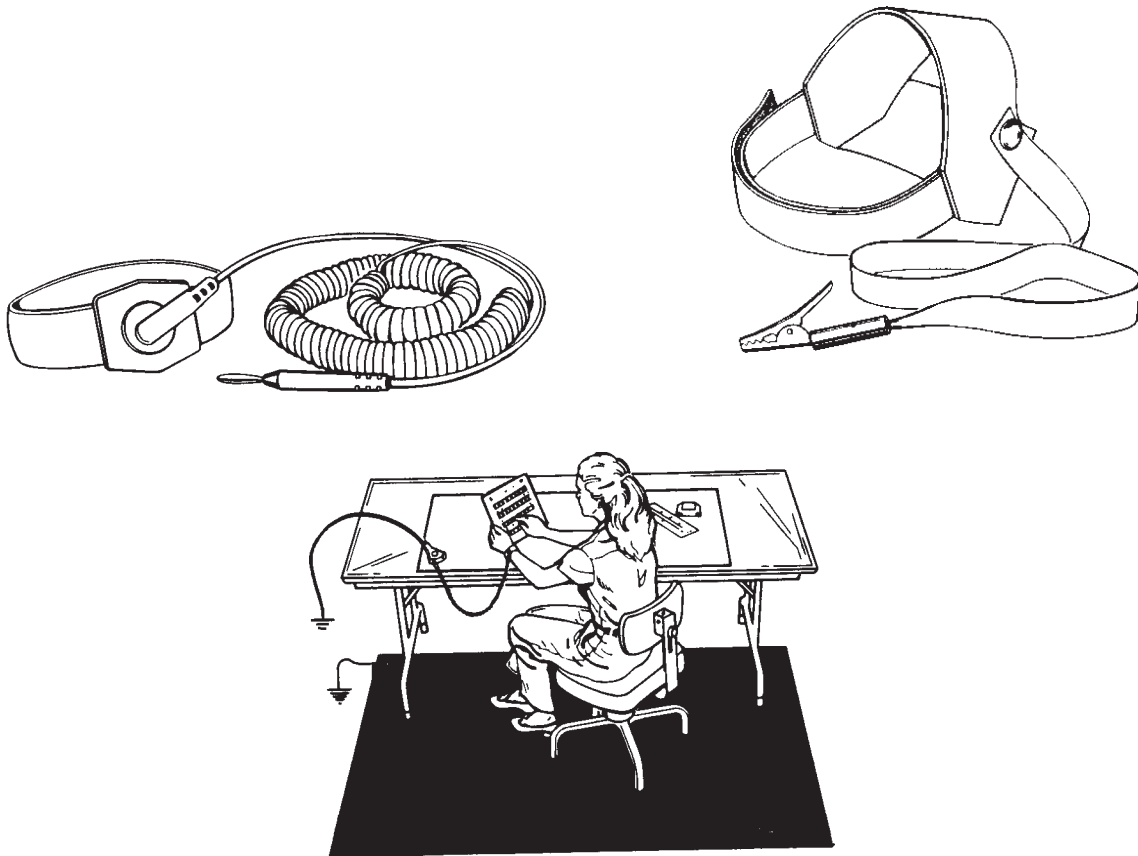
TABLE OF CONTENTS

TOOLS AND MATERIALS REQUIRED

1.   **Tools**

Anti-Static Field kit. It is recommended that an anti-static field kit be kept on any site where solid-state printed circuit boards and other ESD-sensitive components are handled. These kits are designed to remove any existing static charge and to prevent the build-up of a static charge that could damage a PC board or ESD-sensitive components. The typical anti-static field kit consists of the following components:

1.   A work surface (10mm conductive plastic sheet with a female snap fastener in one corner for ground cord attachment).

2.   A 15-foot long ground cord for grounding the work surface.

3.   Wrist strap (available in two sizes, large and small, for proper fit and comfort) with a female snap fastener for ground cord attachment.

4.   A coiled ground cord with a practical extension length of 10 feet for attachment to the wrist strap.

Toothbrush (any standard one will do)

1

2. **Materials**

- Inhibitor (Texwipe Gold Mist ; Chemtronics Gold Guard, or equivalent)

- Cleaner (Chemtronics Electro-Wash; Freon TF, or equivalent)

- Wiping cloth (Kimberly-Clark Kim Wipes, or equivalent)

ESD-SENSITIVE COMPONENT HANDLING PROCEDURE

1. **Introduction**

Microelectronic devices such as PC boards, chips and other components are electro-static-sensitive. Electrostatic discharge (ESD) of as few as 110 volts can damage or disrupt the functioning of such devices. Imagine the damage possible from the 35,000 volts (or more) that you can generate on a dry winter day by simply walking across a carpet. In fact, you can generate as much as 6,000 volts just working at a bench.

There are two kinds of damage that can be caused by the static charge. The more severe kind results in complete failure of the PC board or component. This kind of damage is relatively simple, although often expensive, to remedy by replacing the affected item(s). The second kind of damage results in a degradation or weakening which does not result in an outright failure of the component. This kind of damage is difficult to detect and often results in faulty performance, intermittent failures, and service calls.

Minimize the risk of ESD-sensitive component damage by preventing static build-up and by promptly removing any existing charge. Grounding is effective, if the carrier of the static charge is **conductive** such as a human body. To protect components from **nonconductive** carriers of static charges such as plastic boxes, place the component in static-shielding bags.

This manual contains general rules to be followed while handling ESD-sensitive components. Use of the anti-static field kit to properly ground the human body as well as the work surface is also discussed.

2

Table 1		
Typical Electrostatic Voltages		
	Electrostatic Voltages	
Means of Static Generation	10-20 Percent Relative Humidity	65-90 Percent Relative Humidity
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Poly bag picked up from bench	20,000	1,200
Work chair padded with poly foam	18,000	1,500

2.   General Rules

(1)   ESD-sensitive components shall **only** be removed from their static-shielding bags by a person who is properly grounded.

(2)   When taken out of their static-shielding bags, ESD-sensitive components shall **never** be placed over, or on, a surface which has not been properly grounded.

(3)   ESD-sensitive components shall be handled in such a way that the body does not come in contact with the conductor paths and board components. Handle ESD-sensitive components in such a way that they will not suffer damage from physical abuse or from electric shock.

(4)   EPROMS/PROMS shall be kept in anti-static tubes until they are ready to use and shall be removed **only** by a person who is properly grounded.

(5)   When inserting and removing EPROMS/PROMS from PC boards, use a chip removal tool similar to the one shown in the figure following. Remember, all work should be performed on a properly grounded surface by a properly-grounded person.
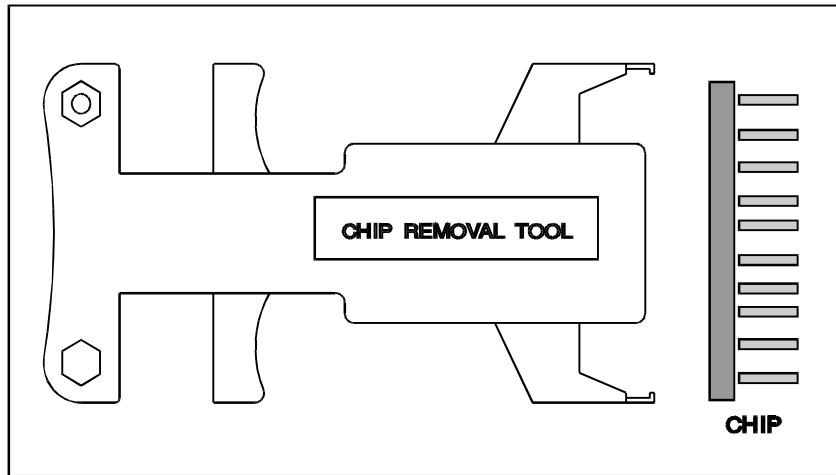
Typical Chip Removal Tool

(6)   It is important to note when inserting EPROMS/PROMS, that the index notch on the PROM must be matched with the index notch on the socket. Before pushing the chip into the socket, make sure all the pins are aligned with the respective socket-holes. Take special care not to crush any of the pins as this could destroy the chip.

(7)   Power the system down before removing or inserting comb connectors/plugs or removing and reinstalling PC boards or ESD-sensitive components from card files or mounting hardware. Follow the power-down procedure applicable to the system being serviced.

(8)   Handle all defective boards or components with the same care as new components. This helps eliminate damage caused by mishandling. Do not strip used PC boards for parts. Ship defective boards promptly to Bristol Babcock in a static-shielding bag placed *inside* static-shielding foam and a box to avoid damage during shipment.

CAUTION

Don't place ESD-sensitive components and paperwork in the same bag.

The static caused by sliding the paper into the bag could develop a charge and damage the component(s).

(9)   Include a note, which describes the malfunction, in a *separate* bag along with each component being shipped. The repair facility will service the component and promptly return it to the field.

3.   Protecting ESD-Sensitive Components

(1)   As stated previously, it is recommended that an electrically-conductive anti-static field kit be kept on any site where ESD-sensitive components are handled. A recommended ESD-protective workplace arrangement is shown on page 7. The anti-static safety kit serves to protect the equipment as well as the worker. As a safety feature, a resistor (usually of the one-megohm, 1/2-watt, current-limiting type) has been installed in the molded caps of the wrist strap cord and the ground cord. This resistor limits current should a worker accidently come in contact with a power source. Do not remove the molded caps from grounded cords. If a cord is damaged, replace it immediately.

(2)   Be sure to position the work surface so that it does **not** touch grounded conductive objects. The protective resistor is there to limit the current which can flow through the strap. When the work surface touches a grounded conductive object, a short is created which draws the current flow and defeats the purpose of the current-limiting resistor.

(3)   Check resistivity of wrist strap periodically using a commercially-available system tester similar to the one shown in the figure below:
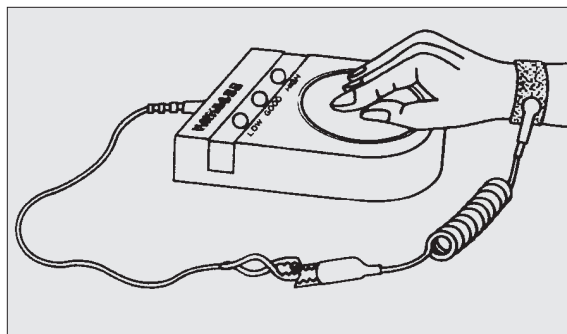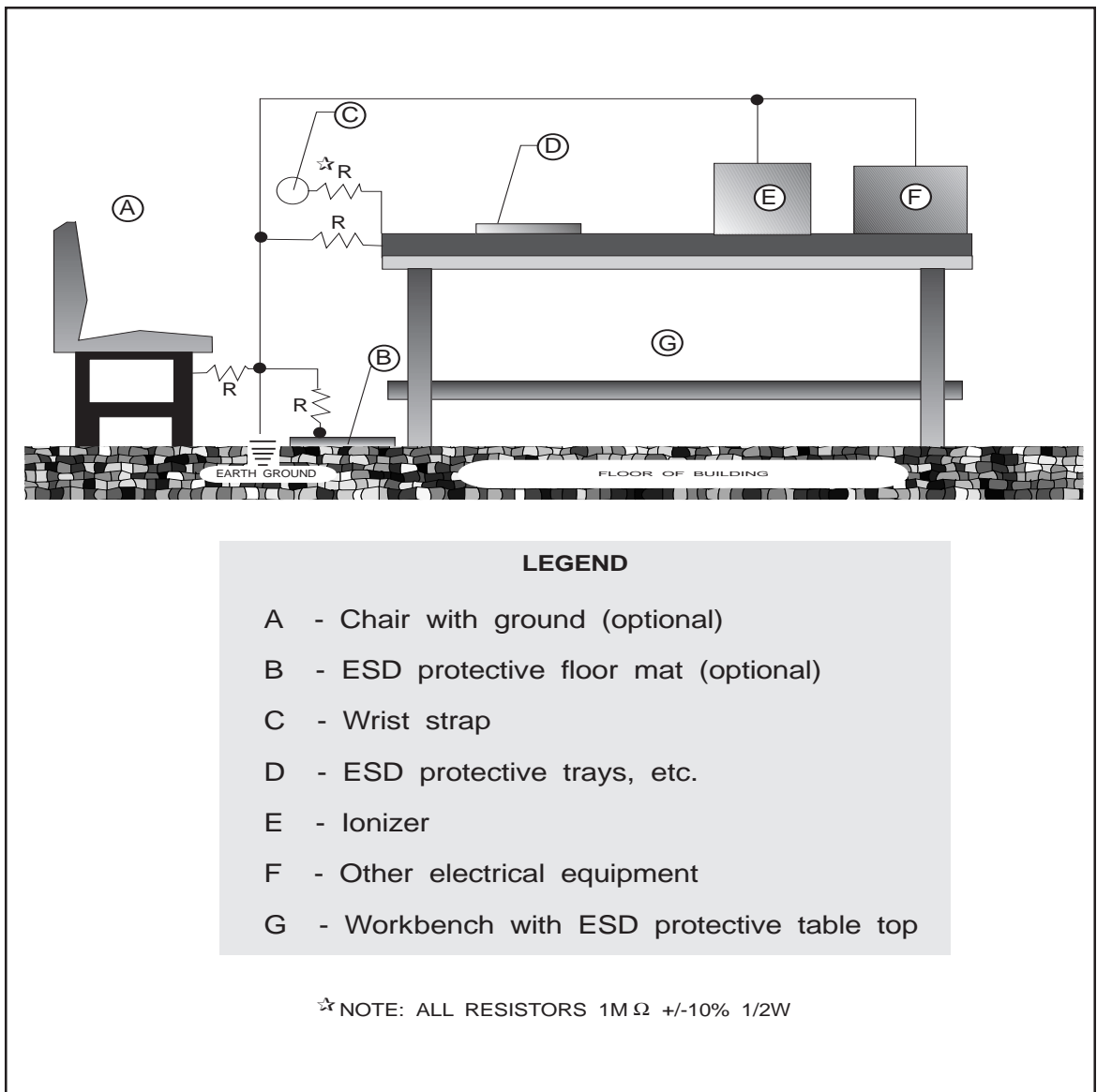
Note: If a system checker is not available, use an ohmmeter connected to the cable ends to measure its resistance. The ohmmeter reading should be **1 megohm +/- 15%**. Be sure that the calibration date of the ohmmeter has not expired. If the ohmmeter reading exceeds **1 megohm by +/- 15%**, replace the ground cord with a new one.

4.   Static-safe Field Procedure

(1)   On reaching the work location, unfold and lay out the work surface on a convenient surface (table or floor). Omit this step if the table or floor has a built-in ESD-safe work surface.

(2)   Attach the ground cord to the work surface via the snap fasteners and attach the other end of the ground cord to a reliable ground using an alligator clip.

(3)   Note which boards or components are to be inserted or replaced.

(4)   Power-down the system following the recommended power-down procedure.

(5)   Slip on a known-good wristband, which should fit snugly; an extremely loose fit is not desirable.

(6)   Snap the ground cord to the wristband. Attach the other end of the ground cord to a reliable ground using the alligator clip.

(7) The components can now be handled following the general rules as described in the instruction manual for the component.

(8) Place the component in a static-shielding bag before the ground cord is disconnected. This assures protection from electrostatic charge in case the work surface is located beyond the reach of the extended ground cord.

EARTH GROUND

FLOOR OF BUILDING

LEGEND

A - Chair with ground (optional)

B - ESD protective floor mat (optional)

C - Wrist strap

D - ESD protective trays, etc.

E - Ionizer

F - Other electrical equipment

G - Workbench with ESD protective table top

☆ NOTE: ALL RESISTORS 1M Ω +/-10% 1/2W

(9)   If a component is to undergo on-site testing, it may be safely placed on the grounded work surface for that purpose.

(10)   After all component work is accomplished, remove the wrist straps and ground wire and place in the pouch of the work surface for future use.

5.   Cleaning And Lubricating

The following procedure should be performed periodically for all PC boards and when a PC board is being replaced.

CAUTION

Many PC board connectors are covered with a very fine gold-plate.

Do not use any abrasive cleaning substance or object such as a pencil eraser to clean connectors.

Use only the approved cleaner/lubricants specified in the procedure following.

WARNING

Aerosol cans and products are extremely combustible.

Contact with a live circuit, or extreme heat can cause an explosion.

Turn OFF all power and find an isolated, and ventilated area to use any aerosol products specified in this procedure.

(1)   Turn the main line power **OFF**. Blow or vacuum out the component. This should remove potential sources of dust or dirt contamination during the remainder of this procedure.

(2) Clean PC board connectors as follows:

a. Review the static-safe field procedure detailed earlier.

b. Following the ESD-sensitive component handling procedures, remove the connectors from the boards and remove the PC boards from their holders.

c. Use cleaner to remove excessive dust build-up from comb connectors and other connectors. This cleaner is especially useful for removing dust.

d. Liberally spray all PC board contacts with Inhibitor. The inhibitor:

- Provides a long lasting lubricant and leaves a protective film to guard against corrosion

- Improves performance and reliability

- Extends the life of the contacts

- Is nonconductive, and is safe for use on most plastics

e. Clean the comb contacts using a **lint-free** wiping cloth.

f. Lightly mist all comb contacts again with Inhibitor.

NOTE: Do not use so much Inhibitor that it drips.

g. Repeat the above procedure for the other PC boards from the device.

(3) Cleaning PC edge connectors

a. Use cleaner to remove excessive dust build-up from connectors. This cleaner is especially useful for removing dust.

b. Liberally spray the outboard connector with Inhibitor.

c. Lightly brush the outboard connector with a soft, non-metallic, bristle brush such as a toothbrush.

    d.   Spray the connector liberally to flush out any contaminants.

    e.   Remove any excess spray by shaking the connector or wiping with either a toothbrush, or a **lint-free** wiping cloth.

6. Completion

(1)   Replace any parts that were removed.

(2)   Make sure that the component cover is secure.

(3)   Return the system to **normal** operation.

(4)   Check that the component operates normally.

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